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THE ISLANDS OF THE AEGEAN

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THE Islands of the Aegean, in a geographical sense, consist essentially of unsubmerged peaks and ridges of that sunken section of the Folded Mountain Zone, which lies between its Anatolian and its Dinaric section; or, more popularly, between Asia Minor and the Balkan Lands south of the Danube. The amount of that depression may be illustrated by imagining it doubled; for with sea level at 6000 feet, practically all these islands disappear, and peninsular Greece becomes an archipelago of much the same extent as the actual Cyclades. The present submergence, in other words, is rather less than half of the total height from sea floor to mountain peaks: Mount Ida in Crete, and Parnassus, just touch 8000 feet, and the sea between Crete and the Cyclades has only small depressions deeper than that, whereas outside the Aegean there are depths of 18,000 feet and 20,000 feet only a few miles off shore. North of the Archipelago, the submergence is less. Olympus nearly reaches 10,000 feet, but the greatest depth is about 5000 feet, and much of the Thracian Sea has bottom at less than 1200 feet. In the Marmara region, though the heights are no greater, the depression is again considerably less.

In these islands, as in the foreshores of the Aegean, so much depends on geological composition, that a word must be added about the principal categories of rock, which are five: (1) the metamorphic schists, marbles, and other crystalline rocks, of indeterminate age, samples of an older world, projecting or protruded surface-wards in the cores of the mountain folds, massive, resistant, infertile for the most part, and usually waterless, but economically significant through their almost complete monopoly of metallic ores and of other minerals such as the white and variegated marbles, the Naxian emery, and the magnesite of Euboea; (2) the massive limestones, Cretaceous and Eocene, the contorted but thick-bedded areas of which are karst country honeycombed with swallow-holes which engulf the rain water as it falls and refund it at lower levels—and much of it below sea level—in deepseated springs; (3) softer marls, clays, and sandstones, the detritus of the crystalline

core and its limestone covering, stratified in former gulfs and old Aegean lake-land, and seldom violently contorted, but clinging on valley sides in eroded terraces, into which surface water cuts abrupt gorges, and from which in turn it carries into the present basins the materials for beds more recent still; (4) the beaches and alluvial foreshores of such detritus above sea level, copious enough locally to have modified the coastline appreciably within historic times, especially in the neighbourhood of the larger rivers, as at Thermopylae, and around Ephesus and Miletus; (5) occasional volcanic accumulations of basalt and lava, by-products of mountain building, together with inshore deposits of pumice and water-sorted tuff, which have economic use for house roofs and for cement. The volcanic rocks, easily disintegrated, and full of iron and phosphates, are exceedingly fertile, and the hot springs which often accompany them have medicinal and recreational value.

This geological repertory is common to the islands and adjacent continental areas. Geographically the essential question about the Islands of the Aegean is this: in what respects does their insular character, the fact that they are thus separated by submergence, and that what is not submerged is essentially highland and mountain peak, affect them as homes for man, and affect each of these homes for men in its relations with other island homes, and with neighbouring foreshores of the mainlands?

But here a preliminary distinction and contrast must be noted, between the northern and eastern foreshores, and the southern and western. To north and east, this Aegean depression is bordered by large continental masses: Asia Minor with its long foreshore set obliquely in front of a watershed from the Dardanelles to the Lycian highlands east of Rhodes; and Europe Minor, obliquely bisected by the Thracian mountain-mass into an eastern and a western lowland, the basins of the Hebrus (Maritsa) and of the Axios (Vardar) and Strymon (Struma). To west and south, on the contrary, there is only false-land; peninsular Greece, dissected by gulfs with isthmuses of 120, 40, and 4 miles respectively, and the island chain from Cythera to Rhodes, with four sea-straits of 40 miles, and two of less than 20, and wide islandless seas beyond as far as Cyprus and Sicily. Consequently islands nearer the continental coast have inevitably shared with them the disturbances, of all kinds, due to changes and movements along a great corridor between inner Europe and the Nearer East; whereas those which lie nearer to peninsular Greece and the southern island cordon have enjoyed comparative immunity from these shocks, though at the cost of exposure to other disturbances originating beyond the open seas, in Italy, for example, or Western Europe.

EUBOEA, lying opposite Chalcis, is separated from the mainland by only a few yards of strait, spanned in mediaeval times by the *Negro-ponte* of sinister memory. Structurally the island continues the mainland range of Othrys in its northern Kandeli highland, and the coast-range of Central Greece south of Mount Oeta and Thermopylae in its southern, Mount Ocha. Historically, the possession of Euboea, and control of its narrow seas, has been essential both to sea-control of the Aegean, and to land-control over peninsular Greece, by alien land powers: Persia, Macedon, Antiochus of Syria, Mithridates of Pontus, the Frank, and Ottoman masters of Byzantium. There was good

The town of Castro, Siphnos

Katakekaumene from Thera (Santorin)

Road from Phera harbour, Thera

The town of Naxia, Naxos

North-west coast of Naxos

Hagios Nicolaos harbour, Ceos

reason therefore at the re-creation of a National State of the Greeks to annex to it Euboea rather than Dodecanese, if it was thought impolitic to give it both; for Euboea, in enemy hands, seemed far the more dangerous neighbour.

CRETE is not easy to treat simply as an island of the Aegean. Structurally it is the mountain rim of the Aegean basin itself. In area, in the diversity of its four mountain masses, and in volume of produce, it is in another category from any other island or group of islands, except Rhodes. In the early days, when men began to move perilously beyond the "narrow seas" of the Cyclades, it was the southern boundary of their universe, a third continent to compare with Europe and Asia; and a dangerous lee-shore all through the sailing season. In the Odyssey, it has already a five-fold mixture of peoples, of whom only one is aboriginal, and one strictly localized at Cydonia in the west end. By that time the sea power of Cnossus had colonized the gulf heads of peninsular Greece, and fallen before the counter-expansion of those colonies. What is not yet explained, is the almost unbroken insignificance of Crete in the Hellenic age; it was a source of mercenary archers and slingers, like the Balearic Islands, a no-man's-land for pirates; a byword for "liars, evil beasts, slow bellies." What had become almost a pirate state, while republican Rome neglected its obligation to rule the waves, became a terrible weapon of the infidel, when the Saracens re-created Cnossus at Candia, and used Crete as the Ptolemies had used it, to dominate the Aegean and link Alexandria with outposts in Melos and Thasos. Similarly, after the Frankish conquests of A.D. 1204, Crete becomes the spearhead of the line of island bases established by Venice from the Adriatic to the Aegean; it was again the instrument of a non-Aegean power, the fourth shore of an Aegean divided against itself. Latterly, it has been Suda Bay, not Candia, which non-Aegean sea powers frequent.

Of the resources of Crete, it is only necessary to note its lack of minerals, its shortage of cornland, its great output of olive oil, wine, and other tree crops; and the curiously narrow margin by which it misses the subtropical climate of Rhodes: for in one sheltered bay on the south side of eastern Crete is the only self-sustained grove of date-palms north of the Mediterranean, now very properly conserved as a national treasure.

Discounting then Euboea and Crete, by reason of their special geographical situations, the other islands fall easily into a few well-marked categories; and it is significant how the rise of an Aegean National State, the modern Hellenic Kingdom, on its peninsular western shore, has been followed by the accession of all these groups of islands except one; and what have been the special circumstances of that exception hitherto.

On either flank of Crete, Cythera with Anticythera, and Carpathos with Casos, continue its structure and mountain landscape, but have little intercourse with it, across so much open and choppy water. Even to sea powers interested in Aegean possessions or pretensions they are of little value, for they are ill-furnished even with anchorages, though Carpathos has one upland plain suitable for an air-landing, and not over far from a landing-cove. We shall hear of Carpathos and Casos again, in connection with their eastern neighbours, of which they are an extreme outpost (p. 145).

THE CYCLADES, the Central Islands, as the name implies, were regarded in antiquity as grouped in a circle round Delos. But this conception does not fully represent their distribution, and on some points misrepresents it. Structurally, and also in their geographical interconnexions, these islands are the exposed peaks of two main ridges, the seaward prolongations of Euboea and of Attica; while Delos is one of the terminal islets of the Euboic chain. This chain has its Anatolian counterpart in Mount Messogis and the Mycale promontory; Samos and Nicaria completing a single great mid-Aegean mountain arc. The other chain represented by Ceos, Thermia, Seriphos, and Siphnos trends thereafter eastward from Cimolos to Amorgos and Levitha, and enframes the two largest and most massive islands, Naxos and Paros, which are also composed of the most completely metamorphic and deep-seated rocks, of which their marbles and emery are typical.

Outside, that is to say, south of this south-Cycladic arc, the crater-islands, Melos and Thera (Santorin) mark a line of volcanic activity between the hot-springs of Lutraki and Thermia, the volcanic cone of Methana, the crater island Nisyros in Dodecanese, and a large inland area, the Katakekaumene or Burnt Country between Caria and Lycia. A similar volcanic appendage to the northern chain is Patmos, which is the western ring of a crater comparable with Thera and Melos, but more ruinous. Thera best illustrates this aspect of the Archipelago. The prehistoric crater, about 4 miles across, smothered a bronze-age settlement under 26 feet of pumice, and carries the mediaeval and modern town on its rim. The Hellenic city, on a cove facing south, avoids the volcanic region altogether. From the old crater rim one looks out over the craters of B.C. 196, A.D. 1711–12, and 1866–67, and in front of these the still smouldering cone of 1925–28. This leaves out of account only Anaphi and Astypalaea; and these were never reckoned among the Cyclades of antiquity, but formed with Thera, an inner group of the Sporades or Scattered Islands which included everything as far as Casos, Carpathos, and Rhodes. Probably Anaphi and Astypalaea, with the non-volcanic peak of Thera should be interpreted as a fragment of a third arc concentric with the other two, and continued through Cos and the mainland ridge north of the Gulf of Ceramus.

This analysis of the structure goes far to explain other physical features, and also the early ethnology. Northern Andros alone has, or had till recently, the mainland rabbits, woolly dogs, and Albanian settlers; elsewhere there are hares, smooth-haired dogs, and Greeks of approximately pure strains. In the first Hellenic expansion the refugees from the South Euboean channel followed the northern island chain to Samos and Ephesus; those from the Saronic gulf followed the Attic chain, but made no progress beyond Ios and Amorgos. Melos, Thera, and all the Sporades were colonized from the Gulf of Argos or Laconia, and spoke Dorian, not Ionian dialects. Leros is said to have been a throw-back from Miletus; in any event it harboured quite a different kind of Ionian from the Cycladic colonists.

How Delos came to its early sanctity is not known; probably its Greek settlers inherited something already immemorial. It stood however at the far end of the northern island chain, and from Delos the long southern arc is perceptible as such, though most of it is out of sight behind Syra, Paros, and

Naxos. It may have been a point of convergence for convoys venturing eastward over the choppy "Icarian waves" to Samos and Asiatic Ionia, and a first port of call for west-bound traffic before it scattered among the gulfs of the Old Country. Certainly in the sixth century its Sanctuary was courted and endowed by states as important as Samos, Naxos, and Athens, and (like Patmos in later times) it seems to have had a chapel, and presumably an estate, as far afield as northern Attica.

THE NORTHERN SPORADES, Scopelos (Peparethos), Sciathos, and Halonnesos, lying off the coast of Thessaly, and the more distant but closely related Scyros, are essentially a prolongation of the coast range of Olympus, Ossa, and Pelion, as Euboea continues the next chain of mountains farther west; and they repeat the mainly crystalline structure of the mainland range. They are rugged, though too deeply submerged to be mountainous, and they stand far enough out into open sea for their sheltered valley heads to be moist and very fertile. The hipped roofs of Scopelos, well named from its precipitous citadel rock, with their whitewashed ridge-tiles, reveal a northern element, due to refugees from Macedonia; but all these islands are of North Aegean aspect and culture, and the contrast between the people and customs of Scyros and of Andros, for example, is most marked.

Quite recent, and lately in the news on the occasion of the destruction of a Greek cruiser in peace time, is the modern counterpart of Delos, the miracle-working shrine of the Virgin at Tenos. Its emergence early in the nineteenth century illustrates the accidental origin of these religious centres: Patmos and Athos are other instances in this region, and Delos may have had similar luck.

In material resources however it was Naxos, not Delos, which dominated this island world, until its regime was challenged in 505 B.C. by Eretria up the Euboean channel; and in the Frankish domination of the thirteenth and fourteenth centuries it was Naxos that became the capital of the Duchy of the Archipelago, and the strategical reserve behind the Genoese and Venetian adventures in Mytilene and Chios, and in Rhodes before its occupation by the Knights of the Hospital. It is from this period that Naxos, Thera, and above all Syra, inherit their congregations of Western Christians.

In the early phases of the National Movement the fine harbour of Melos was used both by Russia and by France as a watching-post over against the Morea, much as Rome had once used Astypalaea to keep watch upon Rhodes and on events in Syria and Egypt. But in the Wars of Liberation themselves the islands took no prominent part, till Syra sheltered the survivors from the massacre of Chios in 1821, and in a few years became the most active commercial centre in Greek waters: a distinction which it retained till larger ships, and facilities for coaling, gave the advantage to Piraeus. Even now Syra remains, what Delos once was, the general exchange for commodities and transport services in the island-world, and its only shipyard for major repairs.

With the sole exception of Syra however modern life made little impression on the Cyclades till *gazolina* motor-boats began to compete with steam and rail, and motor cars made it worth while to build roads hillier than horse-drawn vehicles can use. Even now, for all agricultural purposes, animal-power and wind-power are ubiquitous. With the exception of decorative marble and

of Naxian emery, an ancient resource, and of the pure iron ore of Seriphos, mineral wealth has hardly been touched; and at Seriphos the quarries and shanties are far from the old town, which shrank up hill, like many others, to avoid pirates, and has hardly yet returned to the beach.

All these Central Islands were included without serious dispute in the nascent Greek Kingdom of 1832. They had been of little use to Turkey, and latterly a good deal of trouble. France, on the other hand, was interested in the Western Christians, and Syra had become the second home of the Chians. There was moreover a fairly broad expanse of very bad water between Myconos and Nicaria; less broad and less rough between Amorgos and Calymnos. Astypalaea, by a diplomatic freak, remained Turkish (p. 145).

Very different in position, structure, and history, are what may best be characterized as the Islands of the Thracian Sea: Thasos, Samothrace, Lemnos, Imbros. Their relations with the northern mainland are illustrated by the fact that while Athos is higher than Samothrace, and only a few feet lower than Ossa in Thessaly, the three promontories of the Chalcidic peninsula are joined to the mainland only by the narrowest of low land-necks; that on the eastern side the neck of the Gallipoli Peninsula is but little higher or wider; and that the Dardanelles are geographically nothing but a drowned river valley.

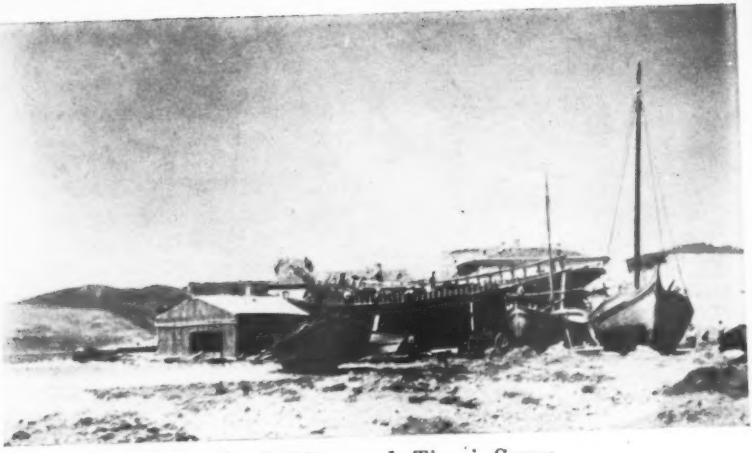
THASOS, repeating the physical features of the metalliferous mountain block between the lowlands of Seres and of Cavalla, won its ancient prosperity less from its own mineral wealth and considerable fertility than from its exploitation of similar resources on the mainland. It was as an outpost against both naval and military aggression along the Thracian coast that it fell into trouble with Persia, and Athens deemed the control both of its mainland dependencies, and of the port of Thasos itself, essential to organized Greek defence against a renewal of Persian aggression. In the quarrels of Alexander's successors it was the hold of the Egyptian Ptolemies on Thasos which gave them initial advantage in disputes with Macedon, and with the short-lived Marmara kingdom of Lysimachus. In Roman times, and mediaeval times, it lay off the main lines of intercourse and conflict; and its fine citadel is unencumbered with Byzantine or Frankish reconstructions, except a watch tower on the summit. Recently, in our own defence of Salonica, Thasos was again an outer guard, like Imbros, to the naval base in Lemnos. The acquisition of Eastern Macedonia and maritime Thrace by the Greek kingdom does not decrease its significance as a naval roadstead; and though its ancient mines are exhausted, its forests, marbles, and wines are of some value.

LEMNOS and IMBROS have always watched the Dardanelles when any sea power operated in or through the Aegean; Imbros never more than an outpost, large enough to take care of itself; Lemnos with its landlocked harbour of Mudros, the Scapa Flow of Greek waters, capable of serving as base for larger operations.

SAMOTHRACE, a volcanic cone so recent, or so resistant, that its contour has hardly a ravine deep enough to shelter a fishing boat, or a shoal to anchor on, enjoyed nevertheless in antiquity a mystical (almost a monastic) prestige, like that of Athos and Patmos in the Middle Ages. It was not without political

Rinia from Delos

Phera harbour, Thera



Ship-building yard, Tigani, Samos

Molyros harbour, Lesbos

Mytilene harbour, Lesbos

intent that Greek kings of Egypt lavished on Samothrace their benefactions, while their ships kept watch from Thasos.

It was to protect the foreshore of Islam that Turkey, and Egypt once again, held so tenaciously to these northern islands; and it was the Turks' own default in 1912 that lost them to the Greek fleet so easily, and thereby assured the transfer of Lesbos, Chios, and Samos. The return of Imbros to Turkey was a concession to sentiment rather than to interest. What was important to Greece was the outer guard of Thasos and the potential naval base at Mudros.

LESBOS, CHIOS, SAMOS, the three greater islands, which lie inshore between the Dardanelles and the Maeander valley, have a general resemblance, which is not wholly a geographical accident, and also a general contrast with the chain of inshore islands from the Maeander to Lycia. Their size alone accounts for much; Lesbos has larger area than Rhodes, though not so well disposed; even Samos is more than twice the size of Cos, and Nicaria, the northern Carpathos, is almost as large. Their intimate proximity to the mainland enhances their peculiar facilities for exploiting foreshores exceptionally fertile and accessible, and avenues into large regions of Anatolia. That none of them, even Lesbos (with the Hundred Islands and Aivali at its door) created a continental protectorate, resulted from their occupation by Greek settlers in the eleventh century B.C., not as solitary enterprises, but as items of a wider immigration which made the whole Anatolian seaboard, from the Hellespont to Lycia, a second motherland, and source of colonies farther afield, and maintained it as a major region of the Greek world until the catastrophe of 1922. For the Turkish conquests of the fourteenth and fifteenth centuries A.D., though they disorganized the mainland cities, with the exception of what remained Infidel Smyrna (Giaour Ismir), left a large countryside population of farmers and peasants of Greek descent and culture, and an industrial and commercial class in almost every market town. Consequently, in recent times, all three islands acquired land and commercial interests on the mainland, especially Lesbos, which colonized the Hundred Islands, in face of Mytilene port.

The resistance of these three coastal islands however was as protracted and effective as it was, not because they were able to maintain and defend themselves, either after the fall of Constantinople or before, but because they had already become protectorates and outposts of Genoa or of Venice (Chios as early as 1172) or of other western adventurers, the Gateluzi of Mytilene, and the Giustiniani of Chios, patronized and supported by those states as outer guards to their own dominions, or similar vassals, in the Cyclades and in Crete. It was from these advanced bases that Smyrna itself was occupied by a western force in A.D. 1344, to be held for more than half a century by the Knights of Rhodes.

Against recurrence of this danger from the south, and as a first step toward the expulsion of the Knights from Rhodes, the Turkish conquest of Samos in A.D. 1453, and the depopulation of the whole island, was a successful precaution. For without Samos, and with no port of their own, the castles of the Knights in Nicaria were useless, and the Knights had to fall back on a second line of defence, based on Cos and a new mainland fortress, St. Peter's

Castle at Budrum. The old Samos on the south coast, fortified, watered, and provided with the world's first artificial harbour, by Polycrates in the sixth century B.C., never recovered; and the modern town is at Vathy, on the other side of the island, looking out towards Chios, Smyrna, and Istanbul.

Yet it is to this exceptional disaster that Samos owes what has distinguished it subsequently from its northern sisters, a rich second growth of forest, and eventually a shipbuilding industry on the old site at Tigani, based on home-grown timber. As late as 1915 only the keels were of a special wood, imported from the mainland. Repopulated as a convict station for recalcitrant Greeks, Samos was given the unusual privilege of a Christian governor and a large measure of self-government, which endured till the Greek occupation in 1912. It was a tragedy that the incorporation of these three large Greek communities within the National State was so soon followed by the total expulsion of the Greek elements from the Anatolian mainland in 1922, leaving the islanders debarred even from their own farms and trading posts beyond the narrow channels, and gravely deranging their economy. By slow degrees however adjustment between Turkey and Greece goes on, in circumstances where those who still have anything to lose have everything to gain by mutual aid.

THE DODECANESE. I have left the Southern Sporades, between Samos and Crete, till last, partly because their intrinsic geographical interest is greater, and their variety more impressive, partly because, in the last thirty years, they have been the subject, while men slept, of an economic and social experiment, and a political and strategical adventure, of which the aim is now clear: to detach them both from their geographical connection with Anatolia, and from their ethnological connection with other islands of the Aegean, and from Greece.

Lying most remote from those frontiers of Greek lands which have been oftenest overflowed by other peoples, these islands have preserved strains or breeds, more purely Hellenic than elsewhere. That does not mean that they are uniform in population, or homogeneous; indeed, part of the proof of their long ancestry is the marked variation between the people of one island and another, the result of long inbreeding. But there are strong common characteristics, which their common fortunes (and misfortunes) have accentuated. Long immune from administrative interference under Rome and Byzantium, under the Knights, and under the Turk till mid-nineteenth century, they have conserved forms of government which have so much in common with those of the smaller Greek city states in antiquity, that they may be regarded as direct survivors of that kind of society.

In the *Journal* for November 1920 I gave a summary account of the Dodecanese, geographical and historical, making use of information collected in 1915–17, not long after the Italian seizure of the islands. In the discussion of that paper, confident hope was expressed that their future might be amicably and securely adjusted. But that hope was frustrated, and it is as an Italian dependency that we must still look on the Dodecanese; and review the geography of those islands in a situation which has its nearest parallel in the second and first centuries B.C. when the principal sea-power of the Mediter-

ranean had its naval base at Alexandria, and Rome was beginning to find in the Nearer East its chief foreign concern.

The Twelve Islands are so diverse in structure and resources, so different in geographical position, and so variously affected by their recent history, that it is necessary to treat them separately, or at most to compare those which present some kind or other of resemblance.

ASTYPALAEA, as we have seen already, does not belong to the coastal islands at all. Like its rugged neighbour, Anaphi, it is an outlier of the Cyclades. It appears in Roman history as a free-and-allied-city, at a time when Rome needed a naval base in the Aegean, to watch the doings of Rhodes. It reappears in mediaeval history, first as an outpost of the Duchy of the Archipelago; then, after the expulsion of the Knights of the Hospital from Rhodes, as a rearguard and post of observation towards the "new order" in what had become the "privileged islands." The name of its landlocked but not very commodious harbour, Maltezana, "Maltese Cove," is significant. Its curious citadel encloses the castle with a ring of inward-facing houses, like the staircases round a college quadrangle, to repel intruders. Under Turkish rule it became a haunt of pirates. In 1832 it was detached from the Cyclades and restored to Turkey by a diplomatist's blunder. For in the original treaty defining the limits of the new Greek Kingdom an astronomical line was found to cut across both Amorgos and Astypalaea, and a supplementary agreement had to be made, exchanging the Turkish half of Amorgos for the Greek half of Astypalaea, which then became wholly Turkish and was attributed to the Dodecanese. Deforested and infertile, it now serves mainly as pasture for store cattle from the other islands, for it lies so far out to sea that it has dew, if not rain, after summer has set in elsewhere.

CARPATHOS and CASOS, similarly, belong physically to Crete as much as to Rhodes; geographically they are fragments of the Dinaric mountain-rim of the Aegean: abrupt ridges of hard rock with little cultivable land. The peak of Carpathos touches 4500 feet, just a little higher than Mount Atairo in Rhodes. Yet in antiquity Carpathos supported three independent cities, and at one time four, besides a tribe of aboriginals in the hills. Near the north end of Carpathos, one sunken valley cuts right through the island, and another very nearly, forming deep ports of refuge or patrol, without access to habitable country. Local waters are too deep for sponge fishing, and the markets too far; but both islands bred bold seamen, with sturdier vessels and more experience of rough weather and heavy seas than islanders nearer inshore. In the Greek Revolution they fought well, and Casos suffered heavy reprisals. Formerly ships were built in Casos; now, as in Leros and Andros, steamships are owned which never visit their port of registry. The colonies of Casos are in the Canal Zone of Egypt, for labourers, attracted by its construction, settled and bred there. Carpathos, though larger than Cos, has smaller cultivable lands: its one inland plain, Lastos, is now an aerodrome. It has lignite, iron ore, and other minerals, but they have not been much worked hitherto.

TELOS, often simply called Episcopi, the "look out," lies nearer inshore, but is singularly isolated; an irregular ridge of hard rocks, with a western lowland of softer material, shelving into an open bay with a landing-place. Other small coves open south-west and south-east. On the ridge, near a copious

spring, are two villages of mean appearance; for Telos exports little but almonds and asses, and much of its surface is uncultivated. Latterly its main use has been as a flash-signal station between Rhodes and Cos, circumventing the mountains of Cavo Crio.

NISYROS, its near neighbour, on the other hand, is fertile and prosperous. It is a volcanic cone, with well-preserved crater and lava-flows, which weather to fertile soil and are terraced for vines and almonds. The only cove is to the north-west, and the little town is dominated by a castle of the Knights. East of the town, over about 2 miles of open pumice beach, is a warm mineral spring, which attracted patients from all parts of the Aegean, as long as they were allowed to come.

PATMOS consists, like Nisyros, of the remains of an ancient volcano, but this is quite extinct and has collapsed, leaving above sea-level less than half of its rim, which can be traced also in the islets east of the main island. Two main segments are connected by a low isthmus deeply indented by three bays; two on the west coast are separated by the ancient citadel; the largest opens eastward, is landlocked, and has the modern landing-place on its south side. Thence, along an inland valley, the road climbs to the Monastery on the southern ridge, with high walls and gates, around which most of the civil population live, though there are many homesteads among the terraced fields. The traditional Cave of the Revelation lies below the road, about half-way between port and upper town, surmounted by a little church distinct from the sanctuary in the Cave. As this part of the island is of pale purple porphyry, which weathers to red, and is very fertile, and as the houses are uniformly whitewashed, the landscape in early summer is a brilliant picture. Farther south the purple changes to black and olive green.

The old shipbuilding industry of Patmos faded when iron vessels came into use, but ships were still sent hither till lately to be broken up. The only other industry is the making of fire-clay cooking pots. Patmos is, of all these islands, the most efficiently developed; because always, since the foundation of the Monastery, local effort has been subsidized by revenue from estates elsewhere. Leros, as we shall see, was formerly another island with independent means; and in the last twenty years the Italian administration has applied the same "pump-priming" finance in Rhodes, and to some extent in Cos. To its distant retainers, and to the Greek people at large, the Monastery has always made appropriate return in its efficient schools. And in the political crisis of 1912 it was to Patmos, as the symbol of their national aspirations, that the other islanders congregated, to found, as they hoped, an autonomous Aegean State.

CALYMNOS and SYMI, of all these islands most closely resemble one another, and their economy is consequently the same. Their people however are very different, though I know nothing but vague folk-memory to account for this. Both are entirely sculptured in the same hard grey limestone as the mountains of the Cnidian peninsula between them. Calymnos rises to peaks of 2250 and 1950 feet; Symi is considerably lower. In Calymnos two deep troughs, lying from north-west to south-east, contain patches of marl and of pumice-shingle from Nisyros, and comprise almost all of the cultivated land and popu-

Lindos, Rhodes

Coast of Chios

Melos bay from above Plaka

Rhodes harbour

The town of Symi

lation. The mediaeval village and Knights' castle stand on steep spurs commanding both Pothaea Bay, where the port and modern town are, and the country houses and fruit plantations at Linaria, perversely called locally Prosta (in front). In the other valley, quite concealed from the sea beyond a flooded gorge where small vessels can enter but not turn, are luxuriant orange groves, another instance of the investment of income from overseas. For this rugged island of Calymnos was lately prosperous and wealthy, by reason of the Calymniotes' great skill in sponge-fishing. When I first knew the island, in 1893, the population was about twenty-four thousand; now it is seven thousand. The fleet of small sailing vessels used to leave Pothaea every spring for Cyrenaica, Tripoli, and Tunis, as well as for Cretan and local sponge-grounds. They were provisioned for the sailing season, and many did not return till the autumn. The older men, and the women, cleaned, trimmed, and packed the sponges for the European market. Chief centres of distribution were London and Frankfurt. In the off-season the women made cigarettes from imported tobacco, many of which were smuggled into Greece.

With their wealth, settlers from Calymnos bought farms on the mainland, and sold European goods in Budrum and up the gulfs. There were similar settlers from Cos. All this was changed, first by the Italian occupation of the islands, and then by the entry of Turkey into the European war. Many sponge-fishers went to America.

Symi, like Calymnos, is a bare and rugged mass of grey limestone not so lofty, but with even smaller area of cultivable soil. The town clusters round the mediaeval castle, on a steep ridge overlooking the deep but narrow port to the north, and the landlocked Pethi gulf on the south. The population, very different in build and temper from that of Calymnos, long throve on its sponge-fishery, and now has its sponge-fishing settlements in South America. Like Calymnos also, Symi had farms and small settlements on the mainland and on the peninsula of Cnidus to the north, where there are both cattle pastures and plantations of olives and almonds. So profitable, intimate, and necessary was this intercourse that it was stopped by the Italians, on the ground that it introduced "undesirable elements" into the Dodecanese. As long as the local timber lasted (and it was only exhausted during the Greek War of Independence) there was a flourishing yard for building sponge-boats and small trading vessels, and for prompt and skilful repairs; but the port is so narrow that large vessels cannot turn in it, and the bay so deep that there is little anchorage outside. Otherwise, its position under the lee of Cavo Crio and of the Lorymna promontory might have made it an important naval base.

COS, at the mid-point of the coastal chain, is only a little smaller than Carpathos, and more varied in landscape and resources than any other island except Rhodes. It consists of two distinct masses of hard rock; from the east end a knife-edged limestone ridge runs west along the precipitous south coast, and slopes more gently northwards. At the west end the rugged headland called Cephalo shelters a small port facing south-eastward, which was the site of the first Greek settlement, the Ancient City (Astypalaea). But the great fertility of the central lowland, of soft marls and sandstones, which extends north of the limestone ridge to the north-east point of the island, drew population and wealth to the site of the present town of Cos, facing the mainland,

and only about 6 miles from it, and about 20 from Halicarnassus, now Budrum. Near this site, too, lay the sanctuary of Asclepios, miracle-worker and patron of Greek medicine, built over a medicinal fountain, one of the series of springs which gush out along the upper slopes of the limestone ridge, supplying the town of Cos through an aqueduct, and irrigating the vines and fruit orchards of Pylli and other large upland villages. The sanctuary has been excavated, and gives a vivid impression of its original outlay. A forcible inscription forbids the throwing of rubbish or bits of food into the holy waters. The town of Cos lies south of a small natural harbour, much altered by the foursquare Castle of the Knights, the gate of which opens on to the ancient citadel overlooking the harbour on one side, and the ancient and mediaeval town on the other. But the earthquake of 1927 shattered the quarter within the Byzantine walls, and this area has now been excavated as far as the Roman level, about 6 feet below the modern floors, though not so as to reveal the Hellenic city which lies below it. The inhabitants, Greeks, Turks, and Jews, have been transferred to modern suburbs inland, and the sea front is laid out with gardens, Government buildings, and the Italian Club.

The wealth of Cos is in its fertile soil and exceptional water supply. In modern times it established a lucrative trade in fresh fruit and vegetables with Egypt, carried till recently in its own spacious and speedy sailing vessels before the seasonal wind. Many other ships since 1900 belong to Greek-speaking Cretan Moslems, who settled here and in Rhodes when Crete was separated from Turkey, but are now said to be passing over on to the mainland, where they may talk Greek among other Moslems. There is an older Moslem population, in the town of Cos and an adjacent village, of Anatolian (perhaps even Turkish) descent, quiet hardworking cultivators of fruit and vegetables. And there is a small urban community of Jews, probably of Spanish origin like the Jews of Rhodes, though being less numerous, they are less easily recognizable. Most of them are craftsmen, shopkeepers, merchants, and contractors.

I have left till last the two islands Leros and Rhodes, which (for different reasons) have been most affected by the Italian occupation, and illustrate the results of a fresh objective and approach to economic problems which are fundamentally geographical.

LEROS has always been popularly associated with Calymnos. In Homeric times they and their satellites were collectively the *Nesoi Kalydnai*: in the Eastern Church they share an archbishopric; in the Admiralty Charts, a single sheet. But they are profoundly different, and lie (as it were) back to back, though the strait is hardly a mile wide, and is infested with islets. For though the southern end of Leros, and also the rough north end, is of the same soil-less limestone as in Calymnos, these ranges are separated by a broad open belt of schist-country, well watered, and fairly fertile, though the soil is light; it is much eroded into small-featured hills rising to the site of the ancient town on the east coast, and sinking into deep bays. Along the outcrop of the southern limestones is a landlocked gulf, Port Laki or Porto Lago, opening west, about 4 miles long and a mile wide near its inner end, where it

floods a deep valley in the southern range. The entrance is only a few hundred feet wide, with a precipitous limestone spur on the south side. This fine harbour was probably too large, and too difficult of access, for use in ancient or in mediaeval times, and it has no habitable stronghold nearer than the old town on the precipitous peninsula between Alinda and Pandeli bays.

Here is as typical a Hellenic and Byzantine site as any we have met hitherto, and the Knights made good use of it in their turn. Seen from the north-east, across Alinda Bay, this citadel hill commands the landing-place in the mouth of the valley which descends into Alinda Bay between the citadel and Meravigli Hill, where (as its Graeco-Latin name, *hemero-vigilia* shows) the day-watchman was posted to give warning of corsairs from the west. There are many such place-names in the islands, and they never fail those who want a wide view, in peace or in war. Seen from the citadel, the Marina quarter sprawls round Alinda Bay; beyond the villas and gardens are the limestone hills around Partheni Bay northward, and the reef-infested Gournia or Thremona Bay on the west coast. Beyond the col, where the Platanos square, with its shady trees and coffee-houses, is the social centre of the town, a similar but steeper valley leads down into Pandeli Bay. From the citadel is seen the whole extent of the mainland, from Samos and Mycale to Cos and Cavo Crio over ancient Cnidus; then, east of south, Port Laki and the southern hills, with Calymnos beyond, white and bleak. Westward, Astypalaea is about 50 miles away, Amorgos, in the Greek kingdom, only about as far, and Naxos about 75. Only to north-west and north does the north range conceal Patmos, Nicaria, and the Fourni group (Panorama, *Geogr. J.* 56 (1920)).

Attention is called to these details because they illustrate the commanding position of Leros as a naval station. So it was proposed to use it against Persia in 500 B.C.; so the Knights used it when they lost Samos; so it was used to watch communications with the Straits and Salonica; and, since 1920, Italy has made Leros and its neighbourhood a military area; strangers are not admitted, and the people of Leros have been encouraged and compelled to move out. This has caused the more distress because Leros, without claiming to be a tourist centre, has so much good land, and good water, that it had become the summer residence of many Lerians and others whose businesses are in Egypt. Patriotic Lerians, like the rich shipowners of Andros, used to register their vessels in the home port, and to spend their wealth on the villas and fruit farms, which occupy much of the lowland heart of their mother-country. Now, if they return, they must stay, as Italian "protected subjects," until it is thought proper to expel them. That large public works have been in progress is evident from the imports of Leros, which have risen to peaks of 130,000, and 500,000 tons, and from the increase in Italian civilians. From the first the Italian administration strictly conserved all waste land, with a surprising response in reafforestation; not with timber trees as yet, but with dense evergreen scrub, excellent cover for the famous Lerian partridges, and for anything else that needs to be hidden. It is not everywhere true that Mediterranean landscape, once deforested, is incapable of recovery.

RHODES, not only is incomparably larger than any other island of this group, but richer even in proportion to its size, for its mountains rise to 4000 feet, and lie so as to intercept the maximum rainfall. The island is

about 50 miles long by 20 at greatest width. It consists of a massive core of hard rocks, poor both in marbles and in ores, but retentive of moisture, and consequently still exceptionally well forested. Over the flanks of this core, and smothering the whole of the northern third of it are level-bedded marls and sandstones, into which the short steep torrents cut narrow gorges. As there have been several changes of level since these beds were deposited, there is more than one terrace or plateau, as in Libya, with abrupt escarpments, and isolated kopjes such as Paradiso and Phileremo, out in the present coastal plain. These terraces and coastlands extend from the northern end as far as Calavarda on the west coast, and Zambica on the eastern. Beyond these points, hard spurs of the central range reach the sea, and south of this there is only an eastern lowland of rolling country and coast marsh between Archangelos and Lindos, and smaller patches of alluvium, the largest of them at Cattavia uniting southern spurs of the main highland to what was once an inshore islet, between Cape Prasso and Caravola.

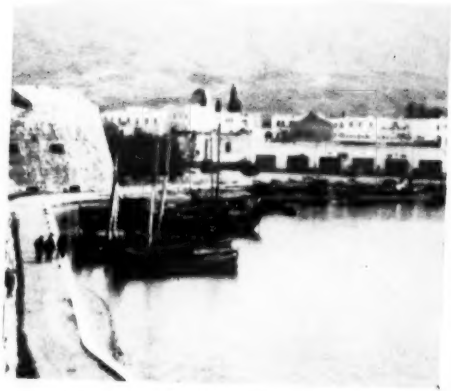
This general configuration explains the Italian air service, with its main aerodromes at Maritza on the upper terrace, looking north-east over the other islands, Calatho in the low ground north of Lindos, and Cattavia in the extreme south, watching the seaways towards Carpathos and Crete. Each of these localities, it may be noted, had also its place in the defensive outworks of the Knights: the Castle of Phileremo covers Maritza, as Lindos covers Calatho; another great Palaeocastro overlooks Cattavia.

The political history of Rhodes illustrates better than any more detailed analysis the bearing of its physique on its human geography, and especially on its dealings with its neighbours, both insular and continental. In the Aegean Bronze Age, while the Cyclades counted for little after the resources of Crete became available, Rhodes was one of the first Minoan outposts and colonies eastward; and with this key position secured, other settlements spread through the coastal islands and touched the mainland at Miletus south of the Maeander. Farther north, Samos and the rough Icarian Sea long barred the way. In Agamemnon's armada against Troy, illustrating actual conditions about 1200 B.C., Rhodes and the same island chain were brigaded in three squadrons with the Cretans, while once more the Cyclades are out of the picture: and Rhodes had already a city at Lindos, looking out over the eastern sea-ways. It was not long after this phase that Aegean settlements appear on the mainland opposite Cos and Samos, and, as we now know, in Samos itself.

In Hellenic times, when overpopulation set in during the seventh century, Rhodes had already held the seas, and joint colonies with Cnidus and smaller islands occupied the south coast of Sicily, adjoining and extending Corinthian and Euboean enterprises from Syracuse to the Strait. At the close of the fifth century the three Rhodian cities, faced with the larger systems dominated by Athens and Sparta, united their resources in the new capital at the north end, heavily fortified landward, far beyond the walls of the mediaeval city, with five wholly artificial harbours built in echelon with fine local masonry, east of what is now a prominent sand-spit, like that at Cos. But I venture to suggest that this sand-spit and much of the flat site of the Borgo Nuovo, as far as the Brusali pier, is subsequent accumulation, and that the famous Colossus stood on the end of the westernmost breakwater, a sea mark visible in both directions.

Castle of the Knights, Cos

Street of the Knights, Rhodes



Cos harbour

Rhodes harbour and windmills at dawn

Rhodes harbour and windmills at dusk

Of the three Rhodian cities which sent ships to Troy, Ialysus and Cameirus, on the low fertile north-west coast, are known by their rich cemeteries, of various early periods, mainly of the bronze age at Ialysus, and of the early iron age at Cameirus. Only at Lindos however was the site typical of an early Greek city, or have the principal monuments been excavated within the mediaeval fortress. A promontory half-way down the east coast is separated from the main range inland by a succession of steep cliffs; in front of all, and separated by a narrow trough, where the lower town and cemeteries lay, the precipitous citadel commands a small cove southwards, and a larger port northwards, with a rock-strewn entrance, but sandy roomy beach within. This safe harbour opened a new field of enterprise, towards Cyprus, Phoenicia and Egypt, as imported objects show in its richer tombs, and records of benefactions from Egyptian kings. Though Lindos took part in the unification of Rhodes in 408, it lay far enough from the new capital, and had sufficient permanent utility as harbour, fortress, and sanctuary, to maintain itself in being until Roman times; and as soon as the seas became unsafe again, during the long decline, it was refortified as a Byzantine outpost, and again in due course by the Knights. For the geographical history of Rhodes in detail, and especially for its struggle with Maussollus and Artmnisia of Halicarnassus for control of the Carian mainland, reference may be made to the *Geographical Journal*, November 1920.

Of the splendid foundation, the ancient city of Rhodes, almost nothing remains except the outlay of three harbours, and even of these only two are now in use. Everything else has been obliterated by the vast fortifications of the Knights of the Hospital of St. John of Jerusalem, who retired from Acre in 1291 and established themselves here from 1310 to 1522, after a surprise attack on the Byzantine city in 1306.

The fall of Acre had ended the Christian occupation of Palestine; but though the Holy Places were now all in Moslem hands, the desire to make pilgrimage to them persisted, and when once the political and military danger had been averted, the practice of pilgrimage was tolerated by the Moslems and exploited by the Knights. Even when Rhodes was evacuated by them in 1522 a pilgrimage was in progress, and had to turn back. And besides the pilgrim business, the new masters of Rhodes exploited the natural resources of the island, and its geographical position on the sea frontier between Levant and Archipelago. The Knights had their consuls in Jerusalem and in Egypt, and several treaties with the infidel. Flanked by the Venetian occupation of Crete to the south, and by the Genoese in Samos, Nicaria, and Naxos to north and in rear, they became a powerful element in Frankish domination over Greek waters. At their strongest they held Smyrna from 1348 to 1412. But Chios fell in 1415, and Samos in 1453, and the Knights had to be their own rearguard at Budrum and Cos, with outposts at Leros, Calymnos, and Astypalaea; inner guards at Nisyros, Episcopi, and Symi; and the castles of Phileremo, Lindos, and Palaeocastro to protect the beaches of Rhodes itself. But it was the new city of Rhodes that was their citadel. On the foundations of the Greek harbours they built the castles of St. Elmo and St. Angelo, and on the land side constructed a more than semi-circular wall with bastions and rock-cut moat, comparable with Famagusta and Candia, and the prototype of

Valletta. It was not so extensive as the Greek walls, which have almost disappeared, but Rhodes of the Knights was a fortress, not a free city, and stood in quite different relation to the countryside, which remained as Greek as ever; and it was probably in this period that the modern Greek quarter took shape, west of the fortress and south of the commercial harbour, on the sand-spit which had been accumulating there since ancient times. The war harbour, as at Candia and Famagusta, was within the great wall, but separated from the city by a high curtain-wall with formidable gates.

Of the Knights' buildings, the best preserved is the Hospital close to the harbour gate, a cloister court of two stories, on to which the main rooms open, with the infirmary occupying the whole of the frontage above the gateway, and the kitchen and service quarters adjacent. The infirmary is a remarkable adaptation of the architectural elements of a Gothic church to its special uses; the nave only two bays long, with multiple aisles, and the sanctuary reduced to an alcove, so that all might join in ceremonies without leaving their beds. One of the greater churches was spared by the Turks, and is their principal mosque; the Cathedral and Grand Master's Palace on the citadel were destroyed by an explosion in 1856. The famous Street of the Knights, some hundreds of yards long, consists wholly of *Auberges* of the principal nations of which the Order was composed, and contemporary houses, with many famous shields of arms. The *Auberges* of France and Italy have been restored, and the English house has been acquired by our own Order of Saint John of Jerusalem. In recent years much of the damage of the siege of 1522 (which was not great) has been repaired, and the modern government buildings are in the Greek quarter outside the west gate.

Until the fall of Constantinople the Knights of Rhodes combined their original function as Hospitallers with the defence of western Christianity against Islam. Of the two chief Moslem Powers the Ottoman Turks in Asia Minor were the nearer and became the stronger, as they increased their hold on the outworks of the Byzantine Empire; hence occasional agreements with Egypt, which could do more to damage the pilgrim trade and other forms of commerce with the Levant. The same policy was followed by Venice, Genoa, and Pisa in 1423; and left Cyprus disastrously at the mercy of Egypt in 1426. Egyptian attacks on Rhodes in 1440 and 1444 were unsuccessful, but diverted Rhodes from the last defence of Constantinople in 1453.

The Turks could now attack Rhodes from the north, and did so in 1480, but without success; and it was not till the Turkish conquest of Egypt in 1517 that the end came. Among the islanders the Knights had never been popular. By the promise to maintain the ancient privileges of what were still constitutionally Greek city states, Suleiman the Magnificent secured their allegiance on his accession in 1522; and in the following year the Knights withdrew from Rhodes to Crete, and thence in 1530 to Tripoli and their eventual home in Malta, whence they made occasional use of the Maltezana harbour in Astypalaea.

CASTELLORIZO, though not an "island of the Aegean," became an Italian possession when the French ceded it in 1920. It lies inshore under high land, about 70 miles east of Rhodes, and is a tabular block of hard limestone, which has split and slid from the mainland, with its upper surface

gently sloping south from about 1200 feet to 600 feet above sea level. The north-west and north coasts are precipitous, with deep water right into the mainland bay of Antifilo. At the north-east angle the strait is about 1½ miles wide. The south-east coast, also mainly precipitous overlooks a shallow bay crowded with islets and reefs, the wave-worn surface of a similar detached block which has foundered deeper. But one deep valley, parallel with the north coast, sinks eastward into a secure harbour gulf, on the south side of which the only settlement rises, terrace on terrace to the Knights' Castle on the ridge. The Hellenic citadel and Byzantine monastery are on a stack of rocks on the watershed, about a mile south-westward. Except a few patches of clay soil in hollows of the rock surface, the island is for pasture only. The people formerly fished sponges, and carried cargo between Egypt and Aegean ports; now about half the houses are empty and most of the men live abroad. In antiquity Magiste ("the greatest" of this little archipelago—whence the Turkish name *Meïs*) usually belonged to Rhodes, a valuable look-out and patrol-base. The Knights used their castle to intern unworthy brethren. In 1912 the islanders declared themselves Greek, but quarrelled with their Greek governor, and fell under French naval control in 1916, and thence into Italian hands in 1920. Here too the severance of island from mainland is disastrous, for the Turkish forests and charcoal burning were worked very profitably by the islanders.

As a dependency of the Ottoman Empire, the Dodecanese has little history. The Turks long kept their promise to respect ancient privileges. Free intercourse with the mainland brought prosperity; Patmos in particular owned merchant ships, and traded as far as Baltic ports in wine and dried fruits; Leros had its turn when steamships were to be had; and the growing population and industrial needs of western countries created a vast market for sponges, which were supplied chiefly by Calymnos and Symi. The present cathedral on the quay at Calymnos was founded in 1802, and the old town in and below the *Castro* was gradually deserted for Pothaea. When the "privileged islands" were excluded from the new National State, their rights were guaranteed by England, France, and Russia.

But in 1866 the administration of the Dodecanese was "assimilated" to that of the Turkish provinces; a British protest was not followed by action; Calymnos was twice occupied by Turkish troops in connection with the Cretan revolt of 1867. Other encroachments followed, and a disturbance at Symi in 1885 was punished by total abolition of ancient privileges; but when I first visited the islands, in 1893, intercourse with the mainland, and between island and island, was still practically free, and Calymnos had a population of about twenty-four thousand.

The Young Turk revolution in 1909, so far from improving the political condition of the islanders, as had been hoped, was followed by heavy direct taxation, and conscription of able-bodied men disorganized the sponge fishery. The only remedy was for the men to fish sponges elsewhere, in Tripoli, an old resort; in Tunis; and in Florida, the Bahamas, and South American waters, maintaining their families at home by remittances. Even in the uneasy state of European politics the Protecting Powers might have done something to protect.

It is not surprising therefore that the seizure of the islands by Italy in 1912 was welcomed and supported, though the successes of the Greek fleet farther north had raised hopes of liberation for the Dodecanese, as well as for Lesbos, Chios, and Samos. Indeed, if Italy had designs on the islands, there was no time to lose. It is not necessary here to repeat in detail the history of the Italian occupation; sufficient to note that on expelling the Turkish in the spring of 1912 they assured the Greek population, which welcomed and assisted them, of "the greatest possible proofs of goodwill," of "the highest respect for your religion, your customs, and your traditions," and of "complete autonomy in the future," after a "provisional occupation." But the first treaty of Lausanne in October 1912 restored the islands to Turkey, confirming Italy in occupation of them till the Turks should evacuate Libya; in 1915 Italy entered the war on a secret guarantee from the Allies of "full possession of the twelve islands now occupied"; and in 1924 this provision was included in the second treaty of Lausanne. What has happened since is difficult to ascertain, since the Italian administration controls communications, and excludes visitors except from well-defined tourist routes in Rhodes and Cos. What is beyond dispute is the declaration of the new Governor, de Vecchi, on his arrival in 1937, that "he had come to bring Fascist life and the Fascist spirit to the islands"; and the decline in the population almost everywhere: in Nisyros by 50 per cent., in Symi by 63 per cent., in Calymnos by 67 per cent., and in Casos by 72 per cent. But with so many of the islanders abroad, much information has been collected which illustrates the practical working of administrative regulations which are themselves official and beyond dispute.

It is only fair to the Italians to observe that from an Italian point of view the islands, and especially Rhodes and Cos, where there are Turks and Jews as well as the Greek "minority" of about 90 per cent., have been administered with scientific skill and lavish expenditure. Besides taxes on land, industry, and trade, and duties on imports, a large subsidy from Italy is necessary to balance the accounts. The towns have been cleaned and materially improved; roads have been built in Rhodes, Cos, and Leros, and some short sections elsewhere, to facilitate defence and tourist traffic, which within strict limits is encouraged. Visitors, mostly from Italy and Egypt, have become numerous (about seventy thousand a year) and profitable. Much has been done, in Rhodes and Cos, to conserve the monuments of the Knights, and something else to exhibit them as cities of the Roman Empire; but the Danish excavations at Hellenic Lindos were summarily stopped in 1912. A large hotel has been established in a forested health-resort and game-preserve. Local industries, such as carpets, tiles, and pottery, are encouraged in the same connection. There are experimental institutes for agriculture and forestry, and the forest areas which remain are officially conserved, and also extended by expelling "unsatisfactory" cultivators. Other areas are being reclaimed for agriculture, as in Libya, by Italian settlement agencies. About 70 per cent. of the produce goes to Italy: chiefly fruit, vegetables, wine, oil, and tobacco; and about 75 per cent. of the imports come thence: recently very large quantities of cement and other construction material have been brought into Rhodes and Leros. Overseas communications are mainly with Italy and in Italian

hands; intercourse with Turkey and Greece is discouraged, but there are air services to Athens (for Italy) and to Haifa for those who may travel.

But the fundamental grievance remains. Though the Turks, and till lately the Jews, in Rhodes and Cos, have been treated with consideration, and though religion is nominally free, the Greek "minority" as it is called, about 90 per cent. of the population, has not only been denied the autonomy which had been promised, but has found it very difficult to live as Greeks at all.

Among a people so widely distributed outside the political boundaries of their National State, the consciousness of national unity, and the patriotic sentiments which it inspires, are mainly sustained by five closely related things: community of material interests; community of social custom and tradition, with whatever measure of local self-government is allowed; community of language, with its indispensable condition; community of education; and community of religion.

On all these points Italian policy has been uniformly repressive. The sponge fisheries have been disorganised since 1912 by Italian monopoly of the Libyan sponge-grounds, which the men of Calymnos and Symi discovered and exploited so long; and in 1915–18 by total prohibition of sponge fishing in the islands. In a region which has always depended for its maintenance on the freedom of the sea, there has been rigid control of intercourse with Greece, with the mainland, and between island and island. There has been vexatious restraint of trade, and competition by state-aided Italian companies and agencies for production, transport, and disposal of commodities. Under pretext of afforestation farmers are prevented from cleaning their fallows, then expropriated for neglecting their land, and replaced by Italian immigrants. Others have been ejected from new military areas.

All schools have been remodelled, in 1926 and again more fundamentally in 1937, with Italian as principal language; no Greek at all in the four lower classes, and thereafter as a "minority" language, like Turkish, and the Spanish dialect of the Rhodian Jews. Visitors are officially requested to speak to natives in Italian, and if Greek speech is overheard there is trouble. Efforts have been made to break the traditional bond between the local church and the Patriarch in Constantinople, to assimilate the local rites and doctrines to Roman and Uniate. There is active Roman propaganda; candidates for ordination must have official permit; orthodox festivals, and even orthodox rites at weddings and funerals are forbidden, and there are many surreptitious burials.

In this outline survey of the Islands of the Aegean, I have tried not to be political; but political facts have their geographical distribution, as well as their historical order; a geographer cannot ignore them, any more than a historian, whether they are of the age of Minos or of Metaxas; and a plain survey of the present, with some glimpses of forces and ideals which have moulded the past, may contribute to intelligent anticipation of an order more or less new, but never wholly separable from the old.

DISCUSSION

Before the paper the PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: I have great pleasure in introducing to you Professor Myres, who is to read us a paper on the Islands of the Aegean with special reference to the Dodecanese. Close on twenty-one years ago he read us a paper on the latter, having then just returned from several years' service as a Lieutenant-Commander in the Royal Naval Volunteer Reserve in the Eastern Mediterranean. The Twelve Islands were then Allied territory. To-day they are in enemy hands and often mentioned in the reports from Headquarters of the Imperial Forces in the Middle East. We are fortunate in having Professor Myres to describe them to us again from a different point of view.

Professor Myres then read the paper printed above.

The PRESIDENT: The time has passed all too quickly, and now I must, without calling for discussion, content myself with thanking Professor Myres very much indeed for his lecture. It is of peculiar interest to-day because before very long the places we have seen illustrated may become what is known in certain sections of the Press as "very hot news." We may interfere somewhat forcibly with the present occupation of the islands. On your behalf I heartily thank Professor Myres for his most interesting lecture.

THE TRANSLITERATION OF PLACE NAMES FROM MODERN GREEK

THE table for the transliteration of Greek, given on pp. 52–4 of *Alphabets of Modern Languages* (R.G.S. Technical Series No. 2. Second Edition, 1933) has proved an unsatisfactory compromise between classical and modern requirements. A revised table has now been made by a staff of transliterators working under the direction of the Secretary P.C.G.N., in consultation with eminent students of modern Greek, and with the approval of the responsible authorities has been adopted for official work now in progress, though circumstances have not allowed its final consideration by the whole Permanent Committee on Geographical Names for British Official Use. In essential features it resembles the system used in Kitchener's Survey of Cyprus (1882), and that proposed by Dawkins, 'The transliteration of modern Greek' (*Ann. British School, Athens*, XV (1908–09) 215–222).

The new transliteration, more strictly in accord with the R.G.S. II system of orthography in general use by the P.C.G.N., gives an approximation to the modern Greek pronunciation and stress, the accent which was a tone-accent in classical Greek having become a stress-accent in modern Greek.

The place names in the preceding paper by Professor Myres are spelled generally in the familiar latinized form. The following table, giving some of their equivalents in the new transliteration, exhibits the more conspicuous changes in spelling:

Alinda (Bay)	Aloúnda
Amorgos	Amorgós
Anaphi	Anáfi
Anticythera	Andikíthira
Astypalaea	Astipálaia
Athens	Athínai
Attica	Attikí
Axios (Vardar)	Axiós
Atairo (Mt.)	Atavírion
Candia	Iráklion
Calavarda	Kalavárdha
Calymnos	Kálimnos
Casos	Kásos
Carpathos	Kárpathos
Cavalla	Kaválla
Ceos	Kéos
Chios	Khíos
Chalcidic Peninsula	Khalkidhikí
Chalcis	Khalkís
Ceramus Gulf	Kéramos
Cimolos	Kímolos
Cos	Kós
Crete	Kríti
Cyclades	Kikládhes
Cydonia	Kidhonía
Cythera	Kíthira
Delos	Dhílos
Dodecanese	Dhodhekanísoi
Episcopi	Episkopí
Eretria	Erétria
Euboea	'Evvoia
Fourni Group	Foúrnoi
Halonnesos	Alónnisos
Hebrus (Maritsa)	'Evros
Ida	'Idhi
Kandeli	Kandhíli
Katakekaumene	Katakekavméni
Laconia	Lakonía
Lemnos	Límnos
Lesbos	Lésvos
Levitha	Levítha
Lutraki	Loutráki
Macedonia	Makedhonía
Melos	Mílos
Mudros	Moúdhros
Mytilene	Mitilíni
Myconos	Míkonos
Nicaria	Ikaría
Nisyros	Nísiros
Olympus	'Olimbos
Ocha	'Okhi
Oeta	Oíti
Othrys	'Othris
Palaeocastro	Palaiókastro
Parnassus	Parnassós
Paradiso	Paradhíso
Pelion	Pílion
Piraeus	Piraiévs
Pothaea Bay	Pothaía Bay
Prosta	'Brostá
Rhodes	Ródhos
Salonica	Thessaloníki
Samothrace	Samothráki
Scopelos	Skópelos
Sciathos	Skíathos
Scyros	Skíros
Seres	Sérrai
Seriphos	Sérifos
Siphnos	Sífnos
Sporades	Sporádhes
Strymon (Struma)	Strimón
Suda (Bay)	Soúdha
Symi	Símí
Syra	Síros
Tenos	Tínos
Telos	Tílos
Thera	Thíra (Santoríni)
Thermia	Kíthnos (Thérmia)
Thessaly	Thessalía
Vathy	Vathí

WATER LEVELS IN FOWLMERE AND OTHER BRECKLAND MERES

PROFESSOR O. T. JONES, F.R.S. AND MR. W. V. LEWIS

Meeting of the Society, 13 January 1941

I. FOWLMERE—BY PROFESSOR O. T. JONES

FOWLMERE lies in Norfolk about three quarters of a mile east of the Thetford–Walton Road 4 miles north of Thetford. It is approached from the main road by an ancient trackway, the Drove Road, which passes close to the south end of the mere and continues eastward towards Roudham Heath, passing just south of Langmere 2 miles east of Fowlmere, and to the north of Ringmere on the Thetford–Wretham Road. These three meres have long been known to be subject to considerable fluctuations of water-level and from time to time to short periods of complete dryness.

The area around Thetford is the Breckland: a very attractive region of heath and coniferous woodland. The characters of the region are partly due to its semicontinental climate and its soil. The underlying rock is chalk, but it is usually covered by a thin though variable deposit of sand and flint gravels: in other places a yellowish chalky boulder clay may occur between the sands and the chalk. Near the meres the ground stands between 120 and 180 feet above sea-level and appears in a general view to be almost flat at around 130–140 feet. The highest point (179) is on Croxton Heath about 1 mile N.N.W. of Fowlmere.

In this almost featureless heathland there are numerous steep-sided oval or circular pits, in the sides of which the chalk may be exposed. These are swallow-holes due to solution of the chalk, and possibly in some cases collapse of the surface into underground cavities. Within an area of some 3 square miles around Fowlmere about fifty of these swallow-holes are shown on the Ordnance Survey maps. The most impressive of them is the Devil's Punch Bowl, which lies on the opposite side of the Drove Road from Fowlmere. There is no prevalent drainage direction in this heathland area and presumably a large proportion of the rainfall must percolate into the chalk, either directly or through its covering of sand and gravel.

For a period before our investigations began the fluctuation of water-level in the three meres Fowlmere, Langmere, and Ringmere, as well as in the Devil's Punch Bowl, is described somewhat fully but in general terms by W. G. Clarke in his work 'In Breckland wilds.' The information for Fowlmere is embodied in Plates 1 and 2.

Fowlmere is an oval or somewhat kidney-shaped body of water; the larger axis extends nearly north and south from Fowlmere Farm towards the Drove Road near the Devil's Punch Bowl. The outline varies somewhat according to the level of the water. At very high stages two narrow arms project from the east side, and at lower stages a small pool lies separate from the mere on the west side. The south-west and west sides are bordered by a mixed plantation of firs and hardwoods but near the water-level corresponding to a moderately

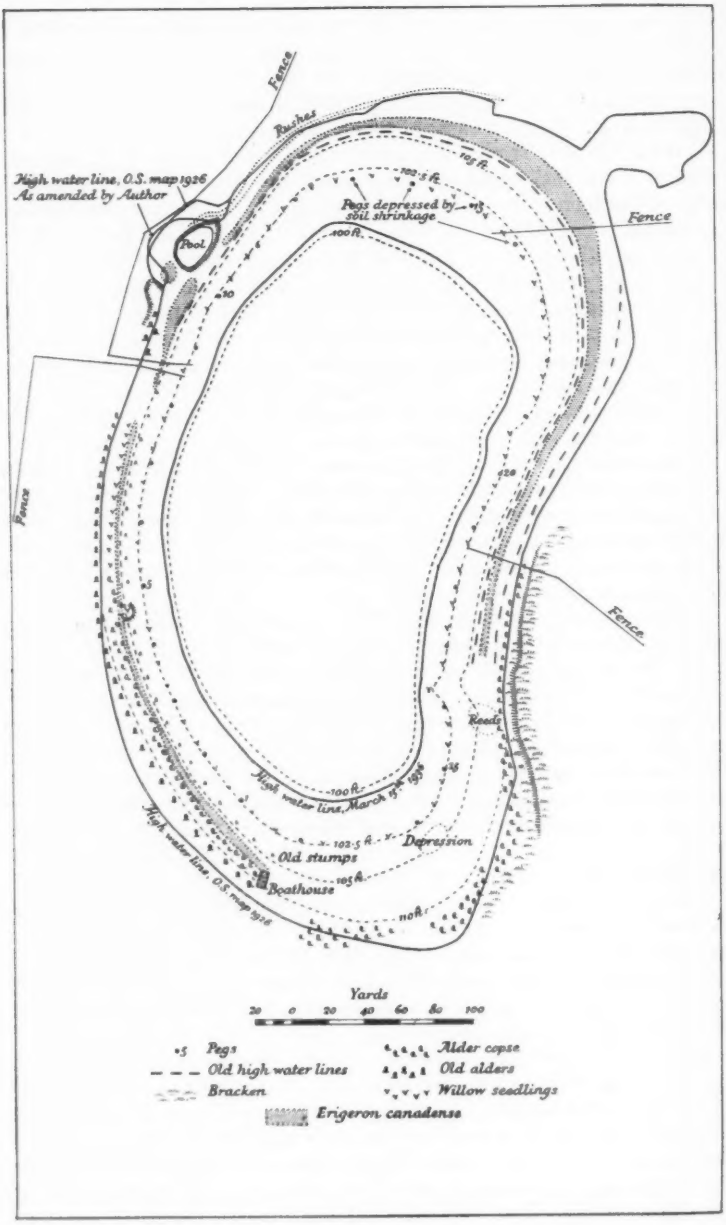
high water stage there is a ring of tall alder trees set at fairly regular intervals. Where these end northwards, pasture land with some bits of scrub borders about one-half the northern periphery; the east side is bounded by a low cliff now somewhat degraded and covered by luxuriant bracken and occasional large fir trees. A narrow copse of young straggling alder trees lies in front of the old alders on the west side and at the foot of the low cliff on the east side; there is also a small copse of alders between the Drove Road and the south edge of the mere. Along with the young alders on the west side there are occasional young willows and about half-way along there is a large prostrate willow projecting beyond the edge of the copse (see map, p. 160).

A photograph of the mere was taken by Professor W. B. R. King about 1910 near the ring of old alder trees on the south side; at that time clearly the alder scrub in front of these trees had not begun to grow. On many of the trees there is a collar of adventitious roots a few inches deep and a few feet above the ground which indicates a former high-level stage of the lake. Lower water stages are indicated by fringes of adventitious roots on young willows and alders; these probably grew about 1932.

Our observations on fluctuations of water-level have not been continuous, but the mere has been visited at frequent intervals since 1932, and on each of these visits notes were made of the state of the mere or the position of the mere edge at one or more places. In the earlier years there was no good landmark to which to refer, but later marks were laid down from which the position of the edge could be defined closely.

In 1932 the mere was very full and was a favourite bathing place in the summer. The water-line passed through the middle of the alder copse on the south side near the Drove Road, and on the south-west side reached nearly up to the ring of old alder trees. In the following summer 1933 people were still bathing in the mere and a boat-house had been erected [? in 1933] at the south end. Towards the end of that summer the water-level began to fall and it was then possible to walk in front of the alder trees. In 1934 the fall of water-level was very marked and in May of that year there was not more than 3–4 feet of water in the deepest parts, so that boys were able to wade about waist high across the middle of the mere from one side to the other. On October 8 of that year the mere was reduced to three small pools at the north end, and by October 15 all these pools had dried up and many dead fish and large live freshwater mussels were lying in one of them. Subsequently the peaty mud occupying the flat floor of the dried-up mere showed a beautiful series of mud cracks resulting from the shrinkage of the mud on drying; for some weeks after the surface began to crack it was still possible to find live mussels several inches down in some of these cracks.

By the end of December the dried-up floor was covered by a short green growth. In the following summer there was a luxuriant growth of tall weeds all over the surface except where about one-half of the peaty floor at the north end, lying in the parish of Wretham, had been ploughed. On 19 January 1936 the floor was still dry, but towards the end of January the water returned in the shallow depression at the north end. During the return of the water the floor was still covered by luxuriant, tall weeds and the water surface was visible only in the area which had been ploughed.


Fence
Rushes
High water line, O.S. map 1926
As amended by Author
Pool
Pegs depressed by soil shrinkage
Fence
Fence
Fence
Reeds
High water line, March 17th 1938
Depression
Old stumps
Boathouse
High water line, O.S. map 1926
Yards
20 0 20 40 60 80 100
Pegs
Old high water lines
Bracken
Alder copse
Old alders
Willow seedlings
Erigeron canadense

By September 1934 a belt of willow seedlings 9–12 feet wide had grown all round the mere; it was suspected that this belt might indicate the position of the water-line at some stage during the falling water-level. The germination of willow seeds, if conditions are right, seems to occur immediately the seeds fall to the ground. The belt thus records the position of the water-line at the time when the seeds of this particular willow (*Salix cinerea*) were dropped. This period is said to be between the middle of May and the end of June. The position of the falling water-level at various dates in 1934 suggests that the water-line was passing across the position of the seedling belt between the end of May and the middle or the third week of June. Other vegetation belts were subsequently noted which appeared to be related to defined limits of water-level. On the north side there was a vigorous growth of *Erigeron canadense;* on the south-west side Erigeron and Epilobium occurred together. The lower margin of this mixed belt lay below the alder scrub and the inner margin was somewhat within that belt, but was indefinite. This belt also undoubtedly represented a stage in the falling water-level when the seeds of this weed were deposited on the soil.

There are other records around the basin of the position of the water-level during the falling water stage of 1933–34. Thus above the upper edge of the *Erigeron* belt there was in 1936 a conspicuous difference in the grass growth at a certain line; above it the grass was rank and coarse, below fine and short. This difference could be recognized with varying degrees of certainty for a considerable distance and probably indicates a former water-level. At a still higher level there is a narrow belt of rushes which can be traced from the pool on the west side to the depression at the north-east end. This belt also probably marks a relatively stationary water-level probably just at or above the rushes.

It is probable that the highest level attained by the mere in comparatively recent times is the foot of the bracken-clad bank on the east side and the lower limit of the bracken generally. It is clear from the steepness and sharp base of the slope on that side that in former times the mere was maintained at about that level for a period of time sufficiently long to develop a cliff and a well-defined beach notch. This period is probably related to the early stages in the history of the mere.

On the alder trees on the south-west side there is however a collar of adventitious roots both on some of the trees nearest the water and on some of those farther back. Those nearest the water are about 3 feet off the ground; those farther back are just above ground level. These roots show that the water-line was stationary at about that level for at least some weeks if not months. The position of the water-line can be fixed on the ground by placing the eye in line with the forward and back collars of roots. The level of this zone was determined approximately by levelling. Adventitious roots belonging to a later period occur also on the young willows of the alder-willow scrub belt. This is probably related to the last phase of high water ending in 1932–33.

Below the lower margin of the *Erigeron* belt there was at the time of the survey a slight step in the surface indicating wave action probably during a halt in the retreat of the water. On the west side there can be seen at low water

stages many short tree stumps 4–6 inches in diameter. The lower limit of these stumps is a level line well below the lower edge of the *Erigeron-Epilobium* belt. They presumably represent trees which had been killed many years ago by a rise of the water-level after a considerable period of generally low water—lasting perhaps ten to fifteen years. There is no evidence when these latter changes occurred.

A high level in recent years is indicated also by the fact that the soil has been washed out from the roots of a prominent large tree on the north side.

Surveys of the Mere basin

The willow seedlings which germinated probably early in June 1934 and had attained in favourable moist places at the north and south end a height of over 18 inches by September 30 and had grown long tap roots. On the drier sandy parts of the slope they were only some 2–4 inches high. In the belief that this band might indicate an approximate contour line on the mere floor it was decided to use it as a basis for a survey of the mere basin. On 8 October 1934 short wooden pegs were put down as near as possible to the mid-line of the belt of willow seedlings and at a uniform distance of 100 feet measured by tape. On October 14 the line of pegs was carefully surveyed by prismatic compass and served thereafter as a datum for recording the water-line after the return of the water in 1936. The pegs served also as a basis for the survey of the mere margin, vegetation belts and other features shown on the map. Several points were tied in to such as could be identified on the 25-inch Ordnance Survey maps, Norfolk, XCIII, 8, 12. The check thus afforded indicated such very small errors at those points that the survey may be regarded as reasonably accurate.

The height of a datum peg alongside the boat-house at Fowlmere was determined by levelling from a bench mark on the Thetford Road about $1\frac{3}{4}$ miles away. The surveyed pegs were then levelled and intermediate readings taken to give the profile along transverse lines not shown on the map. Finally pegs were sunk into the ground in line from the boat-house towards the centre of the mere, each peg being exactly a foot below the one above, a ring of pegs were fixed around the mere at a higher level than the original set. These were intended to act as datum points for future observations of water-level, but were unfortunately interfered with. Similar lines of pegs at 1-foot vertical intervals were fixed at the Punchbowl, Ringmere, and Langmere, and their heights determined by levelling. These and the remaining Fowlmere pegs enabled observations to be taken until many of them, in turn, were removed or otherwise interfered with.

At various times during the rising level surveys were made of the position of the water-line by reference to the pegs on the willow band and, when they were submerged, to the other line of pegs put in at a higher level. By means of the profiles levelled up the slopes it is possible to determine with considerable accuracy the level of the water at the various lines, referred to O.D. These determinations of water-level have a fair degree of consistency among themselves.

The average level of the adventitious roots on the old alder trees on the south-west side is 112·35. These roots probably grew just below the water

surface which must have remained at that level for several weeks at least. The level (112·37) to which the soil at the base of the large tree on the north side had been washed seems to correspond to the same period. The water-level then stood at nearly 113 O.D. The position of the water-line along the south side of the mere on the 25-inch Ordnance Survey map 1926 Edition indicates very nearly the same level, but along the northern periphery it is clear that the mere was standing at a different level when its margin was mapped.

The level when the cliff was developed on the east side exposing the chalk in the bank is considerably higher than 113 O.D. At a level of 110 the mere extends into a depression at the north-east end; on Bartholomew's map a second branch is shown about mid-way on the east side. The southern edge of this branch is probably indicated by the limit of the bracken on that side opposite peg No. 21.

Most of the indications of former level that were in existence during our survey were made during the period of falling water-level which began some time after the summer of 1932. At one part of the north-east side there is a well-defined high-water mark where the waves had made a slight bank at a level between 110 and 111 O.D. The rushy belt round the north side lies between 109 and 110 feet. Since the rushes probably grew just inside the margin the water-level must have been at 110 or perhaps slightly higher. Again on the east side a former water-level at about 109 O.D. is indicated by a sharp change from coarse grass above the line to fine grass below. The latter is probably a new growth on an area of sandy soil on which most of the grass had been killed by submersion.

The belt of *Erigeron canadense* marks the position of the falling water-level during the period of most active shedding of the seeds of that weed. Its upper margin is just below 107 O.D. and its lower margin just below 106 O.D. Another well-defined water-line is shown by a narrow band of well-washed sand and a slight step on its upper side. This was readily traceable from about the middle of the west side near the pond to a point opposite to this on the east bank. It indicates a water-level of about 105·25 O.D. and may mark a pause at this level, or more probably southerly gales during its formation.

The last stage of falling level is recorded by the belt of willow seedlings; its upper and lower margins are at 102·5 and 102 O.D. respectively. The levels of fourteen of the pegs in the willow seedling belt ranged between 101·9 and 102·38, but four of the pegs inserted in peaty ground had obviously been depressed by shrinkage of the ground between the period of drying-off and the date of the levelling. If these are excluded the remainder range between 102·1 and 102·38. The average of these is 102·27 and the four points which have been excluded give an average of 102·04, suggesting that these points had been depressed by shrinkage by 0·23 foot or $2\frac{3}{4}$ inches, which is not unreasonable.

The close agreement between these figures supports the conclusion that the willow band marks very closely a stage in the falling water-level. The lower limit of the row of old stumps is 104·2. The lowest level recorded by the levelling in the floor was 98·6 O.D., and of thirteen points well out in the floor which was levelled the average was 99·3. If 98 be taken as a datum it is probably just below the level where the water dries off. It is probable that the

highest level reached in comparatively recent times was about 113, which corresponds to a depth at the deepest of 14½–15 feet.

From the series of levellings round the periphery of the mere the approximate area of the water surface has been calculated for certain levels. From these data the cubic capacity of the basin can be estimated at these and other levels:

Contour line	*Area in acres*	*Capacity in cubic feet*
100	7·38	299,000
102·5	12·16	1,380,000
105	15·09	2,889,000
110	19·44	6,672,000

At a level of 110 feet the water enters certain small depressions outside the limits of the basin proper. These amount to about 0·56 acres, giving a total area at this level of exactly 20 acres, and a capacity at that level of approximately 42 million gallons. In all stages above medium water-level the average depth is two-thirds the maximum depth. The capacity of the basin at the highest level which it appears to have attained (about 113 O.D.) probably exceeds 60 million gallons.

From a knowledge of the capacity at various depths the average rates of inflow and outflow can be obtained readily for certain periods. These are shown in the table on the following page.

The mere fell between May 6 and 30 September 1934 at the average rate of 10,200 gallons per day. If this rate was maintained after May 6 the margin would pass across the willow belt between about May 24 and June 17. This seems a reasonable time for the casting and germination of willow seedlings. If the same rate had prevailed earlier in the year and the preceding year then the high-water mark at 105·25 would have been made about December 8 and the *Erigeron* belt would have been passed between August 25 and November 3, and the level two months earlier would have been about 107·6. This may be a little lower than the level at midsummer in 1933, which was probably near 108. The water-level in the mere area fluctuates therefore between about 113 O.D. as a maximum and the lowest point on its floor of about 98·5. Since the water-level may sink several feet lower than the lowest outlet the extreme range may be about 20 feet.

If the changes of the mere are directly controlled by fluctuations of the water-table in the surrounding region the level of that table must fluctuate more than the change in level of the mere. When inflow into the mere was taking place during its highest level of 112–113 feet the water-table outside must have been still higher. Correspondingly, when the mere becomes dry the water-table must fall well below 98·5; this indicates a fluctuation of the water-table of well over 20 feet.

From the reappearance of the water towards the end of January 1936 up to May 17 there was an inflow at an average of 8500 cubic feet per day. By June the mere had fallen again to 100·4 and an outflow at the rate of over 22,000 cubic feet per day had taken place.

There appears however to be a seasonal variation of the mere which has been frequently observed. It is usually higher in midsummer than in mid-

FOWLMERE: RATES OF FLOW IN AND OUT

	Level	*Volume*	*Change*	*Interval*	*Flow per day*
1934					
May 6 ..	102·8	1·56 M. cu. ft.			
			−1·49 M. cu. ft.	147 d.	−10,200 cu. ft.[4]
Sept. 30 ..	99·2 [2]	0·07			
1936					
Jan. 25 ..	98·5 [2]	0·00			
			+0·43	50	+ 8,600
Mar. 15 ..	100·4 [2]	0·43			
			+0·42	63	+ 6,700
May 17 ..	101·4	0·85			
			−0·42	19	−22,100
June 5 ..	100·4	0·43			
				51	
July 16 ..	100·4 [1,2]	0·43			
			+0·71	70	+10,300
Oct. 4 ..	102	1·14			
			+0·42	133 [3]	+ 3,200
1937					
Feb. 14 ..	102·8	1·56			
			+0·81	35	+23,100
Mar. 21 ..	104·2	2·37			
			+3·32	210	+15,800
Oct. 17 ..	108·8	5·69			

[1] Approximate figures.

[2] Allowance for shrinkage of mud on drying: at 99·2 it is 0·2; near 100 at edge of mud, 0·15.

[3] Probably fluctuations of level in this interval.

[4] At this rate the mere would be dry in seven days, *i.e.* on October 7. It had certainly been dry some days before October 14, as the dead fish concentrated at the lowest part of the floor were then much decomposed.

winter, and if it runs dry it does so in the winter season. The water-table is probably highest about April and lowest in October to December. If the changes in the mere are related to the rise and fall of the water-table there is a probable lag on the mere level of about one to three months.

There are two possible ways in which the basin is filled or emptied: either by direct percolation through the whole bottom of the basin, which is assumed to be moderately pervious, or by in inflow or outflow in one or more (possibly three) restricted areas of the nature of pipes filled with pervious material, probably fine-grained sand and silt and some mud; the rest of the floor being relatively impervious.

The general level of the area surrounding the mere is between 120 and 125 O.D., and apart from two shallow narrow depressions leading out from the east end of the mere the ground is almost flat up to the edge of the mere basin. The average gradient for inflow would therefore be very small and the rate of inflow would be negligible in comparison with that actually observed at times. Further, there are no signs of seepages from the surrounding area into the mere, apart from a small trickle which flows in at times from the pond

on the west side. This explanation therefore fails to account for the rapid changes of level which have been observed.

It therefore seems that the second alternative must be considered as the more likely. It is almost certain that the basin originated as two or three solution depressions which ultimately became amalgamated into one basin.[1] The basin is therefore probably underlain by one or more restricted pipe-like channels filled with sand, silt, and mud; and the water flows in and out by way of these pipes. This is in accordance with the observation that at times of active inflow certain parts of the mere over these areas do not freeze owing to the inflow of warmer water.

On this view it would appear that the fluctuations in the mere would resemble those of the ground water outside, but damped down; that is the total rise and fall would be less and changes of level would be retarded in time. Since the fluctuation of level in the mere exceeds 15 feet this explanation demands a fluctuation of ground water level of the order probably of 25–30 feet. We have therefore to consider whether it is possible that the mere is in connection with an underground reservoir through one or more pipe-like channels, and this is brought into relation with a large area of ground water.

II. The Water-Levels of the Meres Related to Rainfall and Percolation—By W. V. Lewis

It appears from the foregoing evidence that the amount of water in Fowlmere is largely controlled by the passage of water into and out of the mere through fissures in the underlying chalk. The same is probably true of Ringmere, Langmere, and the Devil's Punchbowl. This implies that the level of the meres is controlled by the chalk water-table. Clarke[2] recognized this and states that the water in the well at Larkshall Cottages, over half a mile from Ringmere, rises and falls at the same time as the water in the meres. Clarke's conclusion that "The rainfall is thus solely responsible for the fluctuating levels of the waters" is however an over-simplification. The representation in Plates 1 and 2 of rainfall and the condition of the meres for the last sixty years shows only a most generalized correlation. The rainfall figures are available for Thetford Waterworks only from 1903 onwards. Before that date the averages for Beccles, Swaffham, and Ely were taken.[3] These places were chosen because they are roughly equidistant from Thetford, and the continental effect of Cambridge should counteract the excessive North Sea maritime effect of Beccles, whereas the heavier rainfall of Swaffham, rather similarly situated to Thetford on the East Anglian Heights, should help to reproduce the circumstances of rainfall at Thetford. The deficiencies of rainfall at Thetford in 1901–02 and 1933–34 are evident, the only occasions in the

[1] J. E. Marr, "The meres of Breckland," *Proc. Cambridge Phil. Soc.*, vol. XVII, 1913, pp. 58–61.

[2] R. R. Clarke, 'In Breckland wilds.' Heffer, Cambridge, 1937.

[3] British rainfall: monthly figures, vols. 1882–1902.

last sixty years on which all the meres have dried out. The greatest deficiency in a single season is for 1920–21, when only Langmere dried out. With these exceptions the fluctuations bear little direct relationship to monthly rainfall, and the behaviour of the water-levels in 1936–37, the only period for which we have fairly detailed information, raises many problems. The graphs of mere levels follow different curves, Fowlmere rising in August and September 1936 when the others were falling, and the water in the well in the side of the Punchbowl shows still different behaviour. Thus, whereas Clarke and the earlier workers deserve full credit for having stated the main elements in the problem, the exact relationship between rainfall and water-levels merits fuller study.

Confirmation of the relationship between the levels of the meres and that of the water-table comes from Chilgrove, west Sussex. These records are contained in a paper[1] by Mr. D. Halton Thomson, Engineer of the Portsmouth Water Company. A very great debt is due to him for much of the data here included, and particularly for his contribution to the analysis of well measurements, without which much of this paper could not have been written. The well records and rainfall observations at Chilgrove reached their centenary in 1935 and are still being maintained. Chilgrove is near the head of a typical dry valley subsidiary to the valley of the Lavant in the South Downs. The surface of the well is 253 feet above O.D., the bottom 108 feet with a boring down to 49 feet O.D. It passes through the lowest beds of the Upper Chalk, but the remainder is entirely in the Middle Chalk. The water-level in this well shows a far closer correlation with the conditions of the meres than does local rainfall. In 1858–59 the wells were unusually low and the meres were dry from 1859 to 1862; the well was rather low in 1890 and again in 1893, by which time most of the meres were also low; the well was very low in 1898 and the meres in 1899; a very low level in the well lasted from 1900 to 1902, and was followed by an equally long-lasting dry period at the meres from 1901 to 1903; the well was again low in 1904–05 and the meres in 1905–06; from 1907 to 1909 the well remained rather low and the meres were also low in 1909–10; finally the well was at its lowest for the whole century in 1933–34 and the meres were dry from 1934 to 1935. Similarly the exceptionally high levels of the meres in 1884 (the highest level ever recorded for Fowlmere), 1912–13, and 1919 correspond with very high and extended maxima of the well-levels from 1879 to 1883 (especially 1882–83), in 1911–13, and again in 1919. Similar maxima in the well-levels in 1903–04, 1909–10, and 1925 correspond with periods when the meres rose rapidly. The analogy can be pressed further in that both meres and well behave normally together; and, what rainfall alone can never explain, the well is generally at its lowest in November, the meres at Christmas time or early January. Thus a superficial examination reveals the similarity between the water-level of the meres in the chalk of south Norfolk and of the chalk well in the South Downs, over 100 miles away. The problem therefore resolved itself into one of obtaining information from early well records of the water-level in the chalk nearer to the Breckland; and then, if possible, a relationship between rainfall and water-table level which could be applied in that area.

[1] *Transactions Inst. Water Engineers*, December 1938.

The only long series of well measurements in the eastern counties have been given me by Mr. W. H. Fordham, of Odsey. The late Sir George Fordham[1] kept daily records of the Odsey Grange well from 1878 to 1888 and a similar record of another Odsey well from 1903 to 1916. These are not sufficiently accurate for minute analysis, but records of the latter well since 1934 have been made with a carefully constructed metal float and copper wire. This Odsey well is about 2 miles south-east of the Ashwell springs, the source of the Cam; the surface level is 256 feet and the bottom of the well 160 feet above O.D. The well is sunk through the lower strata of the Middle Chalk, and is mainly in the Lower Chalk.

Mr. Fordham also gave me the records of a well at Therfield Rectory, which were begun by the late Rector, the Rev. J. G. Hale, in 1878, and are still kept by the present Rector, the Rev. H. R. Humphreys. The Therfield well is about 4 miles south-south-east of the Litlington springs, the surface level 509 feet and the bottom 203 feet. The well is sunk through boulder clay, the bottom of the Upper Chalk, and then Middle Chalk. The Therfield records are more accurate in the later years, but not so accurate as the recent measurements at Odsey. The plotted curves from these two wells show a clear relation with the rise and fall of the Breckland Meres, and it is necessary to examine the question of percolation formulae to see how they can be related with the rainfall records which have been kept continuously at both Therfield and Odsey.

Mr. Fordham, from his own study of the Odsey and Therfield records, produced the following approximate percolation formula giving the behaviour of the water-table from the monthly rainfall figures. The whole rainfall of December to February, together with any excess over 1 inch of the rainfall of each of the months November and March, and the excess of the October rainfall over 2 inches, gives the winter percolation. Mr. Fordham suggested as a tentative formula for summer percolation the excess of two consecutive months' rainfall over 6 inches, or of three consecutive months over 9 inches.

Mr. Halton Thomson has made a more elaborate study of the percolation formula derived from the Chilgrove well and the neighbouring well at West Compton (*Transactions of the Institution of Water Engineers*, 1921, 1931, and 1938). The first step is to examine the rate of fall of the water-table due to the flow of springs in a dry summer when no rain percolates to the water-table. As the flow of springs is roughly proportional to the head of water, the rate of the fall decreases steadily with the time, and the curve which represents it, called the dry weather depletion curve, approximates to a simple logarithmic curve. The water-level L after t weeks $=(L_o-C)m^t+C$ where L_o is the initial water-level in feet above O.D. and m and C are constants to be determined. C is the level to which the curve tends asymptotically.

If D is the fall of level in the time unit, one week, $D=(1-m)(L-C)$, and this should plot as a straight line. At Compton well Mr. Thomson found that $m=0{\cdot}90$, $C=94$. For the Chilgrove he found that the relation of the fall of level in a week from initial levels L_o is not represented by a straight line, but by parts of three straight lines, and attributes this to varia-

[1] *Transactions Herts Nat. Hist. Soc.*, vol. 6 (1889–91) p. 31.

tions in the type of fissure, large, medium, and small, in the different strata of the chalk.

Thus he derives (1938)

For levels above	147 feet	$m=0{\cdot}879$	C=129 feet
Between	147 and 130 ,,	0·926	117 ,,
Below	130 ,,	0·966	101 ,,

In the discussion following Mr. Halton Thomson's paper other formulae were proposed, but the author was firm in defence of his own.

The derivation of the curves for the Chilgrove well is shown on pp. 161–2 of the paper for 1938. It is based upon the rate of fall in the dry periods of 1923, 1925, 1927, 1933, and 1934.

The only part of the Odsey well graph that shows any regularity is the fall from a maximum in the course of a dry summer, when no rain percolates to the water-table; the regularity is well shown in 1904, 1908, 1915, 1937, and 1938. By piecing these curves together, having regard to their relation to O.D., one gets an approximation to a simple logarithmic curve, as Halton Thomson did for Chilgrove, but of course with different constants.

I have determined the dry-weather depletion curve graphically for Odsey, and thus found the amount of percolation that has reached the water-table, given as so many feet rise (r) of the water-table. It has been determined for every month of the Odsey graph by the following method. The dry-weather depletion curve is reproduced on tracing-paper, the tracing is then placed at its correct height and moved horizontally until it coincides with the actual curve at the beginning of the month under consideration; then the vertical distance between the two curves at the end of the month is read off in feet. This amount is proportional to the percolation reaching the water-table in that month, and can be plotted for each month and compared with the rainfall (R).

It is convenient to turn the variation of the well level in feet into inches of percolation to provide a direct comparison with the rainfall. The required factor varies from well to well, being influenced by the distance of the well from springs which form a base level which the water-table approaches asymptotically. Deep wells far from springs generally show greater rise and fall than shallow wells nearer to springs, and there are many other disturbing factors. The only method is to examine the effective rise of the water-table in wet winters when the whole soil is saturated and all further rainfall, except for a small loss due to evaporation, reaches the water-table. To ensure that the soil above is wetted up to its full capacity, one should avoid winters in which the well minimum is as late as December. When the ground is fully saturated the rainfall seems to reach the water-table in from a week to a month.

Table I shows the total rainfall in December, January, and February for selected years at Odsey and the rise of the well from December 7 to February 7, from December 14 to February 14, and the mean of the two. The mean value in these six years is proportional to the rainfall, and the average of the six gives 1 inch of rainfall equivalent to a rise of 4·015 feet in the well.

But even in the wettest winters there are drier periods when evaporation is

not negligible, and there is always the loss of water by transpiration from the vegetable cover of the soil. This can be estimated only from percolation gauges, which give rather different results. I have taken the figures from five different gauges which reproduce as accurately as seems possible the average conditions over the chalk countryside. Excluding months with unusually low rainfall or otherwise erratic, I have taken the figures for rainfall and evaporation for thirty-eight winter months, December, January, or February, from 1922 to 1938 for the Compton gauge, nine similar months from 1935 to 1938 for the Farlington gauge, fifty-one months from 1921 to 1938 for Rothamsted, and nine months from 1937 to 1940 for Fleam Dyke, near Cambridge. One inch of winter rainfall was found to give 0·986 inches percolation at Compton, 0·841 at Farlington, 0·893 at Rothamsted, and 0·675 (turfed) and 0·739 (bare) at Fleam Dyke. Giving the two latter results twice the weight of the others, as nearest to the Breckland, we have a weighted mean of 0·793 inches. And if in default of better we can apply these figures to Odsey, it follows from Table I that of the 1 inch of rain in winter which makes the well rise 4·02 feet only 0·793 has reached the water-table, and that 4·02/0·793 or 5·05 feet is the rise of the well which corresponds to 1 inch of what Halton Thomson calls the ultimate percolation. Therefore in deducing the measured percolation P_m from the well graphs I have taken 5·05 feet to 1 inch P_m for the Odsey well, and 5·49 feet to the inch for Therfield.

I. ODSEY WELL: Relation between Rainfall and Rise in well when ground fully saturated.

Selected season	*Rainfall Dec.–Feb.*	*Rise in well*	
		Dec. 7–Feb. 7	*Dec. 14–Feb. 14*
1903–04	5·88 inches	24·4 feet	22·0 feet
1906–07	4·21	17·8	17·5
1912–13	5·55	25·4	24·0
1935–36	7·59	27·0	28·0
1936–37	9·08	36·0	35·5
1937–38	5·69	25·5	22·4

On the average 4·02 feet rise in the well corresponds to 1 inch of rain, and 5·05 to 1 inch of percolation, P_m.

II. THERFIELD WELL

Selected season	*Rainfall Dec.–Feb.*	*Rise in well*	
		Dec. 21–Feb. 21	*Jan. 1–Mar. 1*
1924–25	7·37 inches	32 feet	33 feet
1925–26	7·10	26	28
1929–30	6·70	24	24
1930–31	6·29	28	28½
1936–37	8·87	36	36½
1937–38	6·10	36	37

On the average 4·35 feet rise in the well corresponds to 1 inch of rain, and 5·49 feet to 1 inch of percolation, P_m.

Having thus obtained a measure of the ultimate percolation in several wells, we have now to find a formula for the monthly percolation which shall in the first place reproduce as nearly as possible the monthly P_m for these wells, and may then be used to calculate the percolation for other places, where there are rainfall records, but no long series of well records. Mr. Halton Thomson has analysed the Chilgrove records for 1922–35, by methods which he has described in *Transactions of the Institute of Water Engineers*, December 1938. These two wells give over four hundred monthly values of calculated percolation P_c to compare with the monthly rainfall, and I have compared them also with calculations based on Fordham's formula. The Chilgrove results and Fordham's values, whilst agreeing well with the average for the percolation at the beginning of the winter, were wide of the mark for any given year. After wet summers the calculated results were consistently low, and after dry summers they were consistently high. After the wet summers of 1924, 1925, 1927, 1930, and 1931 they were in each case 3 inches too small; 1930 and particularly 1931 showed that the months of July to September were the key months. 1926 and 1929 similarly showed as much as 2 inches excess percolation as a result of low rainfall in August and September 1926, and in September and the very early summer in 1929. 1928 was the only year that had normal summer rainfall and for which Fordham's deduction of 3 inches proved correct. The deduction of 1 inch from March rainfall gave a percolation result consistently small. P_m is generally a month or so behind P_c (the calculated value) in early winter, and the best check is the total winter percolation rather than that for any one month. The results for Odsey were also compared, and the lighter rainfall—24 inches per annum compared with 38 at Chilgrove—gave a far better check on the effect of dry summers. Only in the winter of 1912 was the formula fully 3 inches too light, whereas in 1904, 1906, 1911, 1914, 1934, and 1938 all dry summers at Odsey, the formula gave 3 or more inches too high a value for early winter percolation, and again slightly too low a value at the end of the winter. Thus it was found necessary to modify Fordham's formula by making the deduction at the beginning of the winter season depend on the nature of the preceding summer, particularly of the late summer months; also it was necessary to increase slightly the percolation for the end of the winter. A second point emerged from the comparisons—when rainfall in a winter month is low the percolation for the succeeding month is usually, though not by any means always, materially lowered. This deduction however must not be treated cumulatively—if two or three consecutive winter months have very light rainfall the percolation loss the following wet month is not materially greater than when there has only been one month of light rainfall. Similarly if the autumn has been very dry, a dry October does not still further reduce the percolation during the following months.

The correction for summer percolation is somewhat more erratic, especially as the number of occasions on which percolation occurred is much fewer, though certain minor defects stand out clearly. Every summer with the exception of 1929, 1932, and 1935 at Chilgrove the formula gives too little percolation at the start of the season, whereas in 1925, 1927, 1930, 1931, 1932, and 1935 it gives too high a value for the end of the summer.

After modifying the formula in accordance with the above, it was decided to see how closely it applied to percolation values as given in gauges, in the hope that some of the doubtful points about summer percolation, and some further corrections for winter percolation might be possible. The new formula gave surprisingly good comparisons with the percolation gauges in chalk country of south-east England. Accordingly the formula was only modified in some minor details to reduce it to the final form given below:

PERCOLATION FORMULA for calculating monthly values P_c

Take the year to run from October 1 to September 30.

1. To make good the drying out of the upper soil in the preceding summer.
   Take 10 inches minus the rainfall for July, August, and September *or* 7 inches minus the rainfall for August and September:
   Add up to 2 inches if the months preceding July were very dry;
   Subtract 1 inch if the June rainfall was more than 3 inches.
   Deduct this successively from the rainfall for October, November, . . . until the amount of rainfall necessary to make good the summer drying out by evaporation and transpiration has been thus allowed for.
2. When this has been done, take month by month the remaining winter rainfall to the end of February.
   If a month's rainfall is less than 1·3 inches, deduct 1 inch from the next month, but not in two consecutive months, nor in October if the autumn is very dry.
3. From the months following February deduct as follows:

From March	½	inch and another	1	inch if	February	has less than	1·3
April	1	,,	1	,,	March	,,	1·3
May	2	,,	1	,,	April	,,	1·3
June	3	,,	2	,,	May	,,	2·0
July	3						
August	3½						
September	3½						

Note that the formula is not to be applied in the algebraical sense: deducting 3 from 2 produces 0, not minus 1.

The formula is obviously only approximate and use of fractions of an inch have been avoided lest they should give a false impression of accuracy. The introduction of ½-inch deductions for March was unavoidable, and the extra ½ inch for August and September very rarely applies, but the little evidence available was slightly in favour of its being retained. Had the intention been to make the best fit for each locality a different formula would have been used in each case; instead precision has been sacrificed to obtain a formula fitting fairly well over a wide area, and so more suitable for estimating the behaviour of the water-table in the Breckland. The formula only applies to chalk areas, etc., where run-off is negligible.

In Plates 1 and 2 the monthly percolation calculated from this new formula (P_c) is plotted against rainfall and percolation derived from well measurements or gauge readings. The full tables will be deposited in the Library R.G.S. Table III shows the means of the annual totals. The fit between P_c and P_m is very close for the wells; less close for the gauges, perhaps because P_c is designed to be the ultimate percolation at depth.

III. Mean values of Rainfall, P_c, and P_m in inches

		R	P_c	P_m	
Chilgrove Well	1922–35	38·38	21·83	21·88	
Odsey Well	1903–15, 34–39	24·42	8·09	8·25	
Therfield Well	1925–39	26·13	9·60	9·61	
Compton Gauge	1921–38	38·19	21·94	21·59	10 inches soil 24 inches chalk, grassed.
Rothamsted Gauge	1921–39	26·24	10·46	14·85	20 inches loam over chalk, bare.
Farlington Gauges	1933–38	29·92	14·01	13·88	24 inches chalky marl.
				11·48	36 " " "
				10·13	48 " " "
				12·77	36 inches sand.
				12·50	36 inches chalk.
Fleam Dyke Gauges	1937–40	24·05	9·57	12·15	9 inches soil over chalk, bare.
				7·96	9 inches turf.

Gauge results from *British Rainfall* 1921–38

Odsey Well.—The most outstanding difference between Chilgrove and Odsey is the very much smaller amount of percolation at the latter. The graphs of P_m and P_c at Odsey are very similar both in form and amount, with a lag very similar to that at Chilgrove, but owing mainly to greatly reduced percolation, the relationship between rainfall and P_m is not obvious. The exceedingly heavy fall in the summer of 1903 produced an amount of percolation in the summer equal to the total winter percolation for light rainfall years. The low rainfall of 1904–05 is reflected in low percolation for that winter, but then there is little correspondence until the heavy early winter rainfall the following year produces a similar effect; but this is most marked in the winter of 1914–15, and the double rainfall maximum of the winter 1915–16 is again reflected in a double maximum in P_m. P_c, as one would expect, follows the winter rainfall graph more closely than P_m. The relationship between rainfall and P_m continued much the same when the Odsey records were restarted from 1934 onwards. It can be studied in detail in Plate 2.

Below a very few feet the solid chalk remains saturated with water summer and winter, and will not give it up. All the water which percolates from the rainfall and flows into the wells is held in cavities in the chalk, more or less intercommunicating, and the water-table is nearly a free surface, so that a reasonable amount of water drawn from a well for domestic use affects the well level hardly at all, and can be neglected in studies like these. At least in places far away from heavy pumping for town supplies, the fall of the water-table in summers that are dry is due to discharge in neighbouring springs, whose flow depends upon the head of water, so that the depletion curve is naturally of the form found by Thomson. These are the assumptions upon which the present discussion is based.

Therfield Well.—The deep Therfield well was studied in the same way as the Odsey well, but this was done after the percolation formula had been

arrived at, and therefore Therfield provides a rough check. The attempt to relate "r" to rainfall and so to percolation, is more complicated in this case owing to the greater lag between the rainfall and the reaction of the water-level in the well. This is brought out clearly by a comparison between P_m and P_c, and is due to what Halton Thomson calls retarded storage. It is difficult therefore to estimate exactly what is the lag. A comparison was made between winter rainfall in seasons which appeared normal when judged by the same criteria as those used with the Odsey well, and the rise from December 7 to February 7, the 14th to the 14th, the 21st to the 21st, and January 1 to March 1. It was found that the last two compared best and they are shown in Table II. This table is not as consistent as Table I with the simpler regime of the Odsey well, but for that reason it is all the more instructive because it indicates the difficulties in the way of this form of well analysis, when the water-table is partly supplied from a distance. The average of a series of years is taken in order to reduce accidental behaviour as far as possible. From this it appears that 1 inch of winter rainfall produces 4·35 feet rise, and using the same value of winter evaporation and transpiration as at Odsey, 1 inch of percolation produces 5·5 feet rise in the water-table at the well. This result gives the values P_m in Plate 2. The graph of P_m departs from that of P_c with regard to the lag, the flattening of the peaks, and also in the presence of a tail which continues through most summers. The lag is well shown both by the absence in P_m of the early winter peaks shown in P_c (1925–26, 1926–27, 1930–31, 1931–32, 1935–36, and 1938–39) and in the systematic lateral displacement of the bulk of the winter P_m compared with P_c. Heavy summer rainfall affected both P_c and P_m in 1930, 1931, 1932, and 1936. The most conspicuous feature is the fall in the water-table as a result of the 1933–35 drought. The water-table falls below the 253-foot mark in June 1934 and, with the exception of a short period in the summer of 1935, remains below it until February 1936. Heavy percolation in the winter 1935, 1936, and 1937, and heavy summer percolation of 1936, cause a rapid recovery to the highest level of the decade in May 1937. The fact that the lowest level in early 1935 is a full year after the responsible winter drought of 1933–34 is the natural result of the failure of the winter percolation of the dry year, and is made later only by a month or so by the lag between the reaction of the water-level to percolation. The cycle of events outlined above has its exact counterpart in the behaviour of the meres described below.

Estimated behaviour of the Breckland water-table.—The rainfall and calculated percolation at Thetford are represented in Plates 1 and 2 together with the approximate condition of the meres. The state of the meres is variously described by Clarke[1] as "high," "full," "medium," "low," "dry," etc., and so cannot be interpreted precisely. The information is probably the most vague for Fowlmere, the largest sheet, as it is difficult to notice changes which are quite obvious in the smaller meres. Also references to the states of the other meres are more frequent, particularly Ringmere, which is alongside the road

[1] "Norfolk Lakes and Meres," W. G. Clarke, *Trans. Norf. and Nor. Nat. Soc.* vol. II (1921), p. 267, and 'In Breckland Wilds,' R. R. Clarke. Heffer, Cambridge, 1937.

from Thetford to Hockham. The average annual value of P_e for the whole period is 8·1 inches, or an average evaporation loss of 16·1 inches. All the meres were full in 1882 and 1883, and Fowlmere reached an exceptionally high level in 1884 when it was mapped by the Ordnance Survey. This followed the seasons of high percolation—13·2 and 9·3 inches respectively, and the Odsey, Therfield, and Chilgrove figures suggest high percolation for the previous six years. Then follow three years of average percolation and the meres were described as "fairly high" in 1887, suggesting a slight fall from the previous level. Two seasons of very low percolation from 1887 to 1889 apparently only lowered Ringmere, and the effect of the very low percolaiton of 1890–91 is not recorded.

The high percolation of 1891–92 proved sufficient to raise all the levels once more, though after a further season of heavy percolation it is surprising to see Ringmere apparently lower. The rather low percolation of 1893–94 was followed by a considerable fall, Langmere drying out at the end of the year. The fall in 1894 is the first clear indication that the meres fall towards the end of the year in the same way as wells. Fowlmere was full all that year. The moderate percolation the following winter and a rather light amount the next year was nevertheless sufficient to fill Ringmere and Langmere; this might have been assisted by the heavy early winter addition of 1896–97. The exceedingly low percolation for the two seasons 1897–99, a deficiency of 10 inches in the two years, very nearly emptied all the meres. There is no record of the effect of the average percolation of 1899–1900. Then followed three seasons with a total deficiency of 14 inches, accompanied by the longest dry period for the meres in the last sixty years. The excess of 4 inches in 1903–04 filled Ringmere and Langmere, though the former showed the natural fall in level towards the end of the year. Fowlmere had some water in it at this time, showing how much slower that large body of water is to fill than the lesser ones. The second O.S. mapping in 1904 shows the meres very low. The deficiency of 6 inches in 1904–05 resulted in the three smaller meres drying, only to fill again after the average winter percolation of 1905–06. Then followed three years with a total deficiency of 7 inches, ending with all but Fowlmere dry at the end of 1909.

From 1909 to 1913 is the heaviest percolation in the whole series. The percolation of 15·9 inches in 1911–12, which included more than 6 inches August percolation when over 9 inches of rain fell, resulted in the exceptionally high level of the three smaller meres. Then followed many years of uniformly high rainfall and percolation to 1920, interrupted only by the low percolation in 1913–14, after which the meres fell slightly. The second highest percolation value of 15·6 inches in 1915–16 is marked by an exceptionally high level in the records of Punchbowl. A deficiency of 5 inches in 1920–21 emptied Langmere and nearly emptied Ringmere and Punchbowl. Langmere contained some water in the spring of 1922, the normal peak period, in spite of a further deficiency of 4 inches, whilst Ringmere contained some water at the end of that year. By mid 1923 there was a three-year deficiency totalling 10 inches, and yet none of the meres are recorded as dry. Possibly the unusually heavy percolation ending in 1920 reduced the effect of the drought. Heavy percolation from 1923 onwards is accompanied by a progressive rise in the level of

Ringmere and Langmere, but information is then missing until our own observations began in 1933.

From that date onwards the records are fairly frequent, being most detailed during the rise in level of all the meres in 1936 and 1937. Three measurements in the well high up in the side of Punchbowl are also given. A deficiency of $7\frac{1}{2}$ inches from 1932 to 1934 was sufficient to empty Fowlmere, and the winter 1934–35, with a further deficiency of $2\frac{1}{2}$ inches, did not produce a high enough spring peak for the water to reach the floor of the mere, but the heavy percolation of 11·2 inches in 1935–36 did so. The initial rise and fall in 1936 corresponds with that of the normal water-table elsewhere; it agrees with the Therfield maximum but is two months later than that at Odsey. The second peak in 1936 is not shown in the percolation figures for Fowlmere, but nevertheless does show up in both the figures and the wall levels at Odsey and Therfield. So the high rainfall in June and July was evidently sufficient to cause the second peak at Fowlmere. As all three other meres, including the nearby Punchbowl, failed to respond, perhaps it is not the percolation value that is wrong, but that there was considerable direct accession of rainfall to Fowlmere, partly by rain falling on the mere and its immediate surroundings, and partly as a result of a perched water-table feeding into it, such as the one responsible for the Punchbowl well.

Towards the end of 1936 Fowlmere falls into step with the others, three having minima at or just after the end of the year. The graph of Ringmere is interesting because it did not fall with the others, but its rate of rise fell off, and recovered again when the others began to rise rapidly as a result of the very heavy percolation of 14·4 inches in 1936–37. The shallower perched water-table feeding the well at Punchbowl responded immediately to winter percolation and started to fall almost as soon as it ceased, behaviour similar to that of the surface water-table in the gravels at Cambridge. The slight lowering of the level of Fowlmere in late 1938 came at the correct season and also followed a winter of low percolation. The two winters of 1938–40 showed high percolation, and the only observation made indicates that at least a slight rise was in progress, though this might well have been normal seasonal rise in level of the water-table.

The more detailed information from 1932 onwards confirms a conclusion reached from the study of the earlier records, that Fowlmere, particularly when full, reacts very slightly to variations in percolation, but that at lower levels the reaction is much more marked. This is probably due in part to the damping effect of the large body of water in the mere and the time taken for the water to empty through the fissures, and in part to the water-table when the mere is low being in the chalk, and when high in the overlying glacial sands and gravels. Sands can contain as much as 30–40 per cent. of water, most of which can be released as the water-table falls, and has to be made up again as it rises. Therefore small changes of water-level require great quantities of water. The chalk, on the other hand, releases the water held within its pores spaces only to evaporation, which is not possible at a depth, and to great pressure. So the available water of the chalk is almost entirely held in fissures, as indicated by the rise of level at Odsey and Therfield of 5 feet, and nearly 10 feet at Chilgrove, for a percolation of 1 inch. This probably accounts

for the suddenness with which the water appears and disappears from the meres—a fact which has constantly surprised observers—and also for the falling level of Fowlmere in 1932–34 forming a curve convex upwards, instead of concave upwards as in the graphs of the well levels.

The lag of about two months in the rise of level of Ringmere and Langmere compared with that of Fowlmere and Punchbowl in the winter 1936–37 should be tested on future occasions, and if it is a systematic feature it suggests that the former receive accessions of water from a greater distance. Perhaps water reaches Fowlmere and Punchbowl from the higher ground to the north round Frog Hill quicker than that from the rather level plateau to the north and south of Ringmere and Langmere reaches those two meres, but further data are required before any definite conclusions can be reached.

At the outset of this investigation I received much help from Dr. E. W. Russell, Dr. R. K. Schofield, and Dr. H. L. Penman, of Rothamsted. My debt to Mr. W. H. Fordham, of Odsey, for the Odsey and Therfield records has been apparent. My thanks are due also to Mr. H. H. Nicholson and Dr. E. C. Childs, of the School of Agriculture, Cambridge, who have given me much information on the local surface-water table which I have not been able to include in the present paper; as also to Mr. Philip Porteous, Manager of the Cambridge Waterworks Company.

DISCUSSION

Before the paper the CHAIRMAN (Mr. J. M. WORDIE) said: The subject for this afternoon is a joint study of Water levels in the Thetford meres, by Professor O. T. Jones, Professor of Geology in the University of Cambridge, and Mr. W. V. Lewis, of the Department of Geography in that University. Both have given us distinguished papers on other occasions. They have now combined their forces in an attempt to explain certain phenomena which have much interested Cambridge geologists and geographers in recent years. The Thetford meres are one of the main attractions within easy reach of Cambridge: attractive because of the heath country, with its pine trees and heather, and not least the meres themselves.

Professor Jones and Mr. Lewis then read the papers printed above, and a discussion followed.

Dr. R. K. SCHOFIELD (Rothamsted Experimental Research Station): I much appreciate the invitation to be present to hear these two very interesting papers, because the question of water and its movement in and through the soil is one of great interest to me and my colleagues at Rothamsted. I had intended spending a few minutes discussing the question of percolation from rainfall, but that has been so thoroughly dealt with by Mr. Lewis that I do not now think I need dwell on that aspect of the subject. One or two minor points occur to me which it will be best to discuss personally with Mr. Lewis.

Let me now take up the general question of the delay in the response of the meres. It seemed to me from the slides that the delay is much greater in the Thetford meres than in ordinary wells. It seems there may be a delay of as much as a year or two years in response to the general rainfall of the country. I presume that must be due to the response of the meres to rainfall occurring some distance away from them. Therefore that behaviour is never likely to occur in a region of low rainfall standing between a region of high rainfall and

the sea, because the underground movement must clearly be a general movement towards the sea. That is a general proposition. The delay in response certainly suggests that the main cause of the up-and-down movement is rainfall falling on one side and drainage going through the area and then on to the sea. Of course it must take a very long time for any individual modicum of water to travel that whole distance, and one has to be clear in one's mind that that response is the travelling of a pressure wave rather than the actual movement of the water all the way from the region of high rainfall to the sea. In order to get a full understanding of these movements one has to look at the matter in that way; and, in the same way, even in the case of wells which respond more rapidly, I doubt whether it is really the time taken for the water to percolate; it is rather the time those pressure differences take to spread. They can be regarded almost as waves spreading through the sub-soil water.

Being in this building, my fancy tends to fly out and to wonder whether we have not here an interesting light thrown on an even greater question, that of the rise and fall of wells in oases. Naturally one tends to think of a certain part of the desert which has been recently in the news. In such cases we have the phenomenon on an even greater scale. Is there water movement occurring right across the Sahara? How long delayed may not the response of wells and oases be to the rainfall in those areas when one has the thing on that grand scale? I suggest, Mr. Chairman, that the subject which Professor Jones and Mr. Lewis have been studying is one that can and should be followed up. It will, I hope, prove most profitable when considered on the grand scale.

Mr. F. H. EDMUNDS (Geological Survey): Mr. Lewis is carrying out most valuable work, especially if he can establish some figure from which we can obtain the actual percolation. As probably many of you know, the old-established formula has been one-third of the rainfall evaporation, one-third run-off and one-third percolation. Actually well-sinkers and others really have not got beyond that formula. It seems to me that Mr. Lewis is establishing this figure for chalk and, generally speaking, in the areas he has described, for chalk of open porosity. I am not sure what would be the reaction in areas with less permeability, but Mr. Lewis showed one figure in which Mr. Halton Thomson compared the permeability of sand and chalk. Mr. Lewis said it seemed to show that geological formation is relatively unimportant. I think that is so. It does not matter whether it is chalk, sand, or anything else, the soil is permeable. Mr. Lewis has been dealing with areas in which there is run-off. Chalk is absorbent. In the area round Faringdon, which I know fairly well, there is no run-off. In other words, the permeability of the soil is such that all the water which does not evaporate gets down into it. How would this formula apply in areas in which there is partial run-off and partial percolation? These are points which I could discuss with Mr. Lewis privately.

The CHAIRMAN: Perhaps Professor Jones and Mr. Lewis would like to add a word in reply?

Professor O. T. JONES: Mr. Schofield raised the point as to pressure waves in the ground, but I am not sure whether these alone would produce the quantity of water. About 40–60 million gallons of water run into Fowlmere when the water rises. Supposing a general porosity of 5 per cent. in the surrounding rocks, the 20 acres or thereabouts of Fowlmere must presumably drain about 400 acres round about. Time is taken in the travel of the water from the ground into the lake, but I cannot imagine sufficient increase of pressure to cause a greatly increased flow. It is difficult to guess where it goes to when it runs out during falling water level. Fowlmere runs out at times at the rate of 100 gallons a minute. Presumably the water goes to make up the deficiency of the soil water

somewhere else. It is a question how far a flow towards the sea has anything to do with it. I do not know whether there is now a flow in Norfolk towards the sea, but there are certain areas of the chalk inland from the coast in East Anglia where some salt water still remains in the chalk. It is presumably sea water which has not been completely driven out. Presumably there is still a transfer of fresh water from the surface towards the depth in the chalk, but in some areas this has not during the last ten million years or more succeeded in driving all the salt water out of the chalk rocks.

The CHAIRMAN: Mention was made by Dr. Schofield of the wider application which these investigations may have. It seems to me a pity that the observations have had to be suspended owing, as I think Professor Jones said, to lack of petrol. If we can do anything to help the investigations to continue, we should do so. This is work that should go on without interruption. It now only remains for me to ask you to convey your thanks to Professor Jones and Mr. Lewis for their papers.

THE CENTRES OF ENGLAND AND WALES

COLONEL SIR CHARLES ARDEN-CLOSE, F.R.S.

TWO places in Warwickshire claim to be the Centre of England, namely Meriden, where a stone cross is pointed out to the visitor as the exact centre of England, and Leamington, where there is an oak tree which has the same reputation. A post-card, with a picture of the oak, used, I believe, to be sold at Leamington. Now Meriden and Leamington are about 11 miles apart, and it becomes difficult for an inquirer into this curious, if useless, piece of information, to accept both centres as correct, unless indeed he comes to the conclusion that one might be the centre of England whilst the more westerly might be the centre of England and Wales. But I think that neither attribution is correct.

The following definition may be proposed: The centre of any country is that point through which any great circle will divide the country into two parts of equal moment; this of course on the assumption that the earth is a sphere. If the earth is to be treated as a spheroid of revolution, then, instead of "any great circle," we must say "any plane section passing through the normal at the centre." But it will be sufficiently accurate in the following investigation to treat the earth as a sphere.

The usual way of finding the centre of a country is to cut out, in cardboard, or in thin metal, an outline of the country, and to suspend this outline map on a vertical surface from various points on its perimeter, and then to draw vertical lines through the points of suspension. The point where these vertical lines intersect will be the required centre. Or, instead of drawing vertical lines from each point of suspension, a vertical line may be drawn, once for all, on the vertical wall or surface, and its intersections with the perimeter marked. In this case it may be as well to reverse the outline-map and carry out the same process on the back, so as to eliminate the effect of any error in the supposed vertical line.

This process for a small country like England and Wales will give a reasonably good approximation if an atlas map on any usual projection is used: such a projection, for instance, as a conical projection with rectified meridians. But, clearly, as we are concerned with areas, an equal-area projection should be employed. Since we employ straight lines passing through the centre, in the investigation, it will be reasonable that these lines should represent great circles. Thus it will be best to employ the Zenithal Equal-Area Projection of Lambert, with the zenithal point at the required centre. But that is just the point that we want to find.

So it will be necessary to proceed by approximation. We can first find the approximate centre by using any atlas map, and then use that centre as the zenithal centre for our projection, which must be calculated. As a fact, a zenithal centre within a few minutes of the required point will give a substantially satisfactory representation.

In this particular case the writer first took the outline of an atlas map of England and Wales, and having cut out the outline in cardboard, obtained the centre in the way described above. This first, rough position, for England and Wales was: latitude 52° 30′ N., longitude 1° 48′ W.

Then, taking the centre of a Zenithal Equal-Area Projection as being at 52° 30′ N., and 2° W., the coordinates were calculated and an outline map of England and Wales was plotted on cardboard, the outline being taken by reduction from the Ordnance Survey 1/Million. The centre of England and Wales, as derived from this map came out at 52° 32′·2 N., 1° 46′·1 W.

There is a useful way of testing the accuracy of the work by comparing the distances and areas of England and Wales from the combined centre. The separate centres of England and Wales, as derived from the same map, were:

England, Lat. 52° 33′·7 N. Long. 1° 27′·7 W.
Wales Lat. 52° 24′·0 N. Long. 3° 49′·5 W.

Then, if the distance, from the combined centre, of the centre of England is b; and the distance, from the combined centre, of the centre of Wales is a, $b \times 50{,}704 = a \times 7473$, these figures being the areas, in square miles, of England and Wales respectively. The area of England excludes the Isle of Wight, and the area of Wales includes Anglesey. Now measure the length ab on the plotted map, or on any map, and the position of the combined centre is easily found. This comes out, as below:

Centre of England and Wales, by the test: 52° 32′·6 N., 1° 45′·8 W.

But it would not be wise to trust to the measurements from one map. So, as an independent test, I took the Ordnance Survey 1 to 1 Million map, cut out the outline of England and Wales on cardboard, and started afresh. The projection of this map is neither equal-area nor zenithal, but it is not very far from a perfect representation, the maximum error of scale along a parallel being 1 : 434. The meridians are everywhere their true length; one errorless parallel runs through the greatest thickness of country east to west, from Chelmsford, through Monmouth to Milford Haven. The southern parallel of maximum error is that of 50° N., which is mainly in the sea. In the north, the parallel of maximum error, of opposite sign, is at 55° 45′, at Berwick, where the east-west distance is very small. On the whole, no great error is

likely to result from the use of this projection; what error there is will result in the latitudes of the centres being slightly too small. The longitudes will be hardly affected.

Proceeding in the same way as before, I find the following values for the centre of England and Wales:

From projection	.. ..	52° 31′·5 N., 1° 46′·1 W.
By calculation	.. ..	52° 31′·4 N., 1° 46′·5 W.

The following table gives all the results from the two projections :

THE CENTRES OF ENGLAND AND WALES AS DERIVED FROM MEASUREMENT ON TWO PROJECTIONS

Centre of England	Zenithal projection	52° 33′·7 N. 1° 27′·7 W.
	Conical projection	52° 32′·5 N. 1° 27′·8 W.
	Means	52° 33′·1 N. 1° 27′·8 W.
Centre of Wales	Zenithal projection	52° 24′·0 N. 3° 49′·5 W.
	Conical projection	52° 22′·1 N. 3′ 50′·2 W.
	Means	52° 23′·1 N. 3° 49′·9 W.
Centre of England and *Wales*	Zenithal projection	52° 32′·2 N. 1° 46′·1 W.
	By calculation	52° 32′·6 N. 1° 45′·8 W.
	Conical projection	52° 31′·5 N. 1° 46′·1 W.
	By calculation	52° 31′·4 N. 1° 46′·5 W.
	Means	52° 31′·9 N. 1° 46′·1 W.

As a final result it may be said that the centre of England ***and*** Wales will be not very far from lat. 52° 32′ N., long. 1° 46′ W. But this result may be a mile or so in error. The point is about 2 miles N.N.E. of Castle Bromwich, about 3 miles south-east of Sutton Coldfield, and 7 miles north-east of the centre of Birmingham.

As to the centre of England, taking this as being at lat. 52° 33′ N., long. 1° 28′ W., this point is on Watling Street, 4 miles E.S.E. of Atherstone, close to the railway bridge, between the villages of Higham on the Hill and Caldecote.

Although no minute accuracy can be claimed for this investigation, it is, I think, certain that neither Meriden nor Leamington is near the centre of either England, or of England and Wales; Meriden would seem to be some 10 miles distant from either centre, and Leamington about double as far.

NOTES ON JOHN ADAMS AND CONTEMPORARY MAP MAKERS

PROFESSOR E. G. R. TAYLOR

IN an article published in this *Journal* for January 1932 (79.37–44) Mr. Heawood gave a critical summary of the late Mr. Henry Harries' researches into the subject of John Adams and his maps. Later the present writer published some new material relating to Adams' great new survey commenced in 1681 (*Geogr. J.* 90 (1937) 536–9). This note is intended to clear up one or two points raised by Mr. Heawood which still remain obscure. It is based upon two fresh sources of information, namely the advertisements inserted by seventeenth-century map-sellers in contemporary newspapers, and the notebooks of Gregory King, Adams' technical assistant, which are preserved in the William Salt Library at Stafford.

The great map of England and Wales, "full six foot square" which Adams compiled in 1677 was advertised in the daily press in July of that year in terms identical with those quoted by Mr. Heawood from the *Philosophical Transactions*, save that the price was forty shillings instead of two guineas. It was to be had of Gregory King at his private house in Covent Garden, as well as from Robert Morden, Robert Green, and some other booksellers. Rivalry in map production was very keen, and it may have been due to Adams' success that early in 1678 there appeared an advertisement of "Saxton Revived, the Best Map of England Extant," a version of Saxton's map to which Ogilby's roads and a number of extra towns had been added. This was sold by John Cade and by William Morgan, Ogilby's nephew and successor. This issue is twelve years earlier than that noted by Mr. Whitaker in his list of Lancashire maps as the first reprint of Saxton with added roads.

In July of the next year, that is, 1679, the following advertisement was issued: "Mr Adams of the Inner Temple, having formerly published a new large map of England whereon an account of Miles is entered in figures, hath now contracted the same into two Imperial sheets of paper, and hath added the rivers and an Alphabetical Table of all Cities and Market Towns, with Letters referring to the Map, the distance of every Town from London and their several latitudes and longitudes etc." Subscribers were directed to apply to Adams' agent, a Mr. Pen, at his stationer's shop near the Temple Church. Four months later John Seller, John Oliver, and Richard Palmer advertised for subscriptions to their proposed *Atlas Anglicanus*, a collection of County Maps. By February 1680 they were able to announce that the surveys of Middlesex, Surrey, and Hertfordshire were completed, the original draughts of the maps being on view at Seller's and Oliver's shops. The survey of Kent (which appears to have been carried out by Seller himself) was in progress.

In the same month, Adams advertised that he had undertaken to publish a new *Index Villaris* on or before June 29, the work actually appearing in November. In the Preface he announced his own intention of making an actual survey of England and Wales with a view to producing a series of

county maps, declaring that Seller and his partners had produced only one-twelfth of their series in the course of two years: the inference being that their scheme, like the earlier one of Ogilby's, was going to fail. This brought from them an indignant rejoinder in the shape of a Broadsheet (now in the Bagford Collection) printed on 7 January 1681: "Mr. Adams, not being contented to prosecute the Conceits and Chimeras of his own brain, without scandalous reflections on their [Seller's and partners'] undertakings, having no grounds or just cause so to do: (as for example) he never saw any part of their Survey, or knew what progress they had made therein, and how he should be capable of judging they leave it to the judgement of the Reader, and the Work to justify itself, which is always to be seen at the shop of the said John Seller in Pope's Head Alley, Cornhill, John Oliver and Richard Palmer in the Old Bailey near Ludgate, and by their Surveyor in the Counties where he is at work." They claimed that Middlesex, Surrey, Hertford, Kent, Berkshire, and Oxfordshire were complete, while parts of Bedfordshire, Hampshire, Gloucestershire, Wiltshire, Worcestershire, Sussex, Buckinghamshire, and Essex had already been surveyed. Actually however little if any further progress was made. Of the six maps said to be complete, five are known, the exception being the map of Kent, possibly because no copy has survived.

Thirteen years later, in 1694, John Oliver announced that "having engraved a large map of Hertfordshire" he proposed to print with it a table of the Nobility and Gentry. In 1697 he advertised a Map of Essex, 4×3 feet, also with a list of local gentry, and stated that he was engraving maps of Surrey and Bucks from actual surveys. After this date nothing more is heard of him, and at about this time old Seller's career likewise drew to an end. Robert Morden's set of compiled county maps held the field.

Turning now to Gregory King's notebook, we find further details of the making of Adams' "contracted" map of 1679: "Accounted with Mr. Adams for my work upon his two-sheet map of England at £26 8*s*. which with £3 12*s*. remaining on a former account makes up £30. Lent Mr. Adams in money £25, and took his bond for the whole £55 with 10/- interest from 1st July [1679] to 1st Sept. Note that Mr. Adams two-sheet map was just 3 months in graving, viz: from 25 March excl. to 24 June incl." Meanwhile King and his father, a Lichfield surveyor also named Gregory King, with the assistance of a third professional surveyor named Wm. Gent, were carrying out a survey of Staffordshire, respecting which a hundred prospectuses and subscription forms were distributed to booksellers and others early in March 1680. Subsequently however the lay out of this map was modified so that it could form part of Adams' new county series, and it was never published. King also worked on the Hearth Rolls, from which material was obtained for the forthcoming *Index Villaris*, and his notebook contains a long series of entries of which the following is an example: "1679, Dec. 20. Due from Mr. Adams. Abstracting Durham from the Hearth Rolls . . . 12 hrs. Entering the latitude and longitude of Yorkshire . . . 32 hrs," and so on to a total of 194 hours. Then follows: "One day transcribing letter C . . . 10 hrs." etc., entries which have reference to the alphabetical lists of towns.

King is remembered to-day chiefly by his contributions to the then new science of "Political arithmetic," that is to say vital statistics, and in par-

ticular for his estimate of the population of England and Wales by social categories. The fact that he had not only studied the Hearth Rolls, but had travelled widely on survey work lends great weight to his estimates. As a young clerk to Sir William Dugdale he made drawings and copied inscriptions up and down the country especially in churches; as assistant to Ogilby and Morgan he conducted part of the great road survey, besides surveying the county of Essex and the City of Westminster in company with Robert Falgate. His survey of Staffordshire has already been mentioned, and doubtless not all his work has been recorded. There is however no evidence that he travelled with Adams through the Welsh Border, Somerset, and Devon on the new survey begun in 1681.

John Adams had a brother William who was a professional surveyor, and it was to him that the most important operations were to be entrusted. The brothers were Shropshire men, and their own county was the first it was hoped to publish, followed by Chester and Hereford, in which areas William Adams had earlier conducted surveys in the course of his profession, and by Staffordshire already half finished by the Kings and Gent. A new measure of the degree was to be an incidental result of the survey, for the measured base for the primary triangulation was declared to be longer and therefore better than Picard's. All these high hopes were disappointed for lack of financial support.

One small point only remains to be noticed. In 1696 Robert Morden advertised for sale a "New Map of England and Wales dedicated to King William" and measuring 6 feet. This is undoubtedly Philip Lea's edition of Adams' large map, and it seems likely therefore that this was the year of its publication, hitherto a matter of conjecture.

ILLUSTRATIONS TO PROFESSOR O. T. JONES' PAPER: CONTINENTAL SLOPES AND SHELVES

WE were unable last month to publish with Professor Jones' paper the necessary illustrations, because what seemed to be the only copy then in England of the Geological Society of America's Special Paper No. 7 had been returned to the Geological Society of London and immediately sent out again on loan. By the courtesy of the Geological Society, and of the Fellow who had borrowed it, the Paper with its case of Charts was soon after placed at our disposal, and we are now, thanks to them, able to produce the two plates which are essential to understanding Professor Jones' discussion of the Topographical Contours of the Continental Shelf, drawn by the late Mr. A. C. Veatch from the ranges of echo-soundings made in the last few years off the north-eastern coast of the United States by a cooperative arrangement between the Geological Society of America and the U.S. Coast and Geodetic Survey.

It will be remembered that in Special Paper No. 7 the authors describe how they first drew "mechanical connections" between the lines of soundings on the assumption that between any pair of adjacent soundings the slope is uniform, so that contours of standard interval can be interpolated. But they found that these mechanical contours, by which they mean contours drawn without any preconceived idea of what their shape should be, do not suggest any structural shapes akin to the conditions of the coastal belt inland, nor do they suggest volcanic forms. They believe, then, that the sole remaining alternative is a stream erosion topography, and by combining the soundings of one area with knowledge of surrounding areas, they develop by contours a greatly dissected surface, which gives a picture of the sea-bottom topography that is in their opinion essentially correct.

As a small experiment in testing this conclusion Professor Jones took an area of Chart IIIA for which on its companion Chart IIIB a new line of soundings had been inserted, too recent to have been used in drawing the contours of IIIA, and not shown upon that chart. Using only the soundings that were shown on IIIA, and carefully avoiding any recollection of the new soundings on IIIB, he made his own "mechanical" contours for this area, then laid down upon his plot the line of the new soundings, scaled off along it the points where this line intersected his mechanical contours, and asked us to construct a section based upon these figures alone. We have also at his request constructed a section to represent the topographical contours of IIIA along this line AB, and another to represent only the new line of soundings, which are quite independent of the other two. These three sections have been superimposed at the bottom of our first plate, and it is immediately evident that Professor Jones' mechanical contours fit the new soundings much better than do the topographical contours of IIIA which have been drawn on the assumption of a stream erosion topography. They seem to justify fully his conclusion stated on p. 94: "The topography that I obtained is much nearer that revealed by the new soundings and the greatest discrepancy is 60 fathoms." The largest discrepancies between the new soundings and the section based on the contours of IIIA are about twice that. And more significant than individual numerical discrepancies is the fact that not

one of the four major spurs that cross the section line eastwards is confirmed by the new soundings.

Earlier in his paper (p. 88) Professor Jones remarked: "It would appear however that much of the exceptional trend which is displayed in this region is due to the direction of the sounding traverses. In between many of these lines ridges and furrows are shown trending parallel to the traverses for which there does not appear to be any justification in the sounding data." To illustrate this we may be allowed to take an area $10' \times 10'$, which is shown on Figs. 24–27 of Special Paper No. 7. On our second plate the first of the four representations is enlarged from Fig. 24, which is contoured at 50-fathom intervals from the soundings of 1933, by mechanical connection. To the right is the same area with topographic contours, in which we may note especially the re-entrant of the 1200-fathom contour, based on the theory that the contours of Fig. 24 are contrary to nature, and that the topography must be due to subaerial erosion. On the third example, a new mechanical contouring based on data including work in 1934, we observe that a new line of soundings has required that this hypothetical re-entrant be abolished and replaced by a blunt salient of the 900 and 1000 contours. There is no example of the topographical contouring at this stage.

But in 1937 several more lines were run, and the consequent revision of the topographic contours makes Chart IIA, of which Fig. 28 shows part on a scale too small to do justice to its elaboration.

Our fourth figure is therefore traced and reduced from the Chart IIA itself. New lines of soundings are indicated by marginal rays and letters, A to B, C to D with a sharp turn near D, and a small piece E. The rays and letters H, K, L, and M indicate older lines which have been strengthened by inserting additional figures, presumably from the original records, since the intervening numbers are unchanged. The remaining older and more sparsely figured lines have not been thus reinforced. It has seemed better to indicate the new material in this way, rather than to attempt on this smaller scale to reproduce the figures of the soundings, especially since the figures in the earlier stages, enlarged from the blocks in No. 7, are scarcely legible, though they serve well enough to show where the lines of soundings were run. One may observe that the 1200-fathom re-entrant of Fig. 25 has become a very long narrow salient of the 900 and 1000 contours, though the new soundings do not seem near enough to warrant it. This fairly illustrates, we may think, Professor Jones' suggestion that exceptional trends are due to the direction of the traverses. But we should add that exceptional difficulties in producing the *Journal* at the moment have thrown the responsibility for choosing these examples of the second plate upon the Editor.

Since the above was written we have obtained for our library a copy of Special Paper No. 7 with the accompanying charts, and the Director of the United States Coast and Geodetic Survey has very kindly presented to the Map Room six copies each of Charts I to V, of which I to IV show the soundings only, without any contours. Two copies of each have been placed at the disposal of Professor Jones for further experimental contouring; and others may be consulted by those interested in the questions raised by him.

REVIEWS

EUROPE

CORN COUNTRY. By C. Henry Warren. *London: B. T. Batsford*, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* viii + 136 *pages; illustrations.* 10*s* 6*d*

This volume, with its many illustrations, is an interesting account of the grainlands of eastern England. The first part is a brief résumé of grain growing in England and the social and economic consequences of enclosure. Part II follows the seasonal activities of the farmer and those concerned with the harvest. The illustrations, which include reproductions from paintings, photographs, and line-drawings, both modern and old, add greatly to the value of the book and give a reader an impression of this topic more vivid than that obtainable from official publications. Part III is principally an argument for the increase of corn cultivation, as it gives fertility to the land of a more valuable kind than that given by artificial manures. The writer regards the impoverished state of British agriculture as due to the desire of importers to gain the maximum profit from foreign grains, without regard to the welfare of the home producer. He adds a warning as to the evils which will follow an attempt in England to introduce large fields with mechanical cultivation. Written by an author with an enthusiasm for his subject and for the past, this volume is recommended to all interested in either East Anglia or agriculture. A. C. O.

CAMBRIDGE. By John Steegmann. *London: Batsford*, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* viii + 120 *pages; illustrations and end-paper maps.* 10*s* 6*d*

This book is well conceived in three main parts: a brisk history of the town and University, an account of their buildings, and an essay on the University to-day, written for the visitor by a former resident. It tells the stranger what it is thought convenient to know about the history of the place, and provides a wide, judiciously selected, and lively critical survey of Cambridge architecture, which residents as well as visitors would be wiser and better for studying. It is very thoroughly illustrated with excellent photographs rather drearily reproduced, with a selection of prints, and with a scrubby and out-of-date map. The distractions of war among which it has been brought out excuse some, but not all, of its many mistakes; and these, though they disfigure the book, by no means destroy its great merits.

The historical section carries us pleasantly down to the age of reform: only its last chapter, covering the period from 1837 to 1920—and for Mr. Steegmann 1920 is the present day—is slight to the point of futility. The chapters on the character of the University to-day and in the future are topically and may become historically interesting. The solid part of the book is the architectural part. In fifty-seven pages the author surveys the whole progress of Cambridge building, from the nameless masons of the Middle Ages, through Symons, the Grumbolds, Wren, Gibbs, Wright, Burrough, Essex, Wilkins, Cockerell, Basevi, Salvin, Waterhouse, and the rest down to Baker, Lutyens, Maufe, and Giles Gilbert Scott. There is no room for descriptive writing, and little attention to any but strictly architectural considerations, slightly coloured by sentiment. This is just what was wanted and excellently done; and deserves, what we hope it will some day achieve, a second and corrected edition.

D. A. G. H.

ASIA

JENGHIZ KHAN. By C. C. WALKER. *London: Luzac and Co.*, 1939. 10×6 *inches; 216 pages; maps. 17s 6d*

Squadron-Leader Walker has handled very competently one of the geographical aspects of the great Mongol conquests. Not knowing the several languages that would be necessary, and only an occasional very great scholar has known them all, he has not been able to review the original sources afresh and critically. Nevertheless he uses well the great mass of detail that is available in translation. Many of these details may contain original errors or later misunderstandings. Such is their quantity however and so wide their geographical distribution, that they have a good statistical reliability. That is to say, a very large number of individual facts could be challenged without impairing the working value of the material as a whole, because the kinds of error that are likely to be found in such material are just as likely to cancel out as to be cumulative. With this text and maps any soldier, without being an expert on Mongol history, can feel confident that he has adequate data for a general military study of the campaigns of Jenghiz or Chingghis.

In other, more subtle and ultimately more important respects, Squadron-Leader Walker's handling of geographical factors is not so satisfactory. Not that this is his fault; he is the victim of tradition. This tradition is in itself an interesting problem in the history of ideas. Gibbon, in writing his 'Decline and Fall,' did not have the volume of geographical information about Nomad Asia that has been built up in the last hundred years. Yet his insight into nomad migrations and wars, and his perception of the nature of the conflict between "the barbarian" and "the civilized" is remarkable. Many writers of the last hundred years are not up to Gibbon's level, and very few of them are above it. Perhaps this is largely because of the conventions of evolutionary and environmental thinking that became established in the nineteenth century. As these conventions became popularized, they tended also to become too rigid and too simple. Prevailing ideas of "the nomad" are now so solidly set that they are actually an obstacle to further advance in the elucidation of nomad history—including nomad warfare and the way in which migration at times builds up to the intensity of warfare and at other times provides an escape valve, facilitating "deceleration" from warfare to peaceful trade and pastoralism.

The author follows the general trend in treating the Mongols of the time of Jenghiz too much as simple products of their environment. In reality, the primary influence of the environment in creating the Mongol type of life and society was far earlier than the time of Jenghiz. For many centuries the steppe-nomads had been mature enough socially and advanced enough in their technique to maintain, within the steppe environment, a considerable range of economic and political forms. By the thirteenth century there was a complicated interplay of forces: the influence of the environment continued, but it was modified by the social control of man over it. A single point may be taken to illustrate this interplay. The author states that "in order to prevent desertion, it was forbidden a troop commander to receive in his command a man who had belonged to another troop." As a soldier, he readily accepts the idea of an arbitrary standard. Now laws of this kind recur in more than one Mongol code. The steppe environment encouraged movement from pasture to pasture. Tribal chiefs however always did their best to limit and control movement, because of their need to be able to summon followers from known territories. This led to a conflict within the Mongol society. The non-noble tribesman, whenever he could, used his ability to move as a kind of safeguard; he would always desert to

join a better chief if he could find one. Ambitious chiefs, accordingly, built up their following by winning men away from other leaders; while the great established chiefs attempted to forbid private change of allegiance. When therefore a great paramount chief like Jenghiz forbade "desertion," he was really intent on guarding himself against possible rivals—marshals and nobles under his rule who might attempt to build up forces whose allegiance was to them instead of to the Great Khan. The importance of this dualistic desertion and recruiting is proved by the career of Jenghiz himself. He rose to power partly by breaking allegiance and alliances; but he did so with such political skill that he always had moral justifications.

Many other statements and assumptions which are either inadequate or downright wrong make this a book to be used with the most cautious reserve as a guide either to the historical setting which made possible the career of Jenghiz or to the political aspects of his relations with other nomad khans, with the Kin, Sung, and Tangut states in China, and with Central Asian rulers. Military activity always works within a political frame. Squadron-Leader Walker does not understand this frame; but he has written an excellent introductory handbook to the purely military deeds of Jenghiz. O. L.

AFRICA

THE FINANCIAL AND ECONOMIC HISTORY OF THE AFRICAN tropical territories. By Sir ALAN PIM. *Oxford: Clarendon Press* (*London: H. Milford*), 1940. $7\frac{1}{2} \times 5$ *inches;* vii + 234 *pages; map.* 10*s* 6*d*

Sir Alan Pim gives in these Beit Lectures an outline of the economic history of the European tropical territories, summarizing the present state of economic development from available official statistics, interpreted in the light of his own experience. He points out that colonial statistics at present afford no measure of internal trade, of native production, other than of export crops, or of industrial activity. Conclusions have therefore to be drawn from the returns of external trade and of public revenue and expenditure, and they are governed by the difficulty of assessing invisible imports and exports, which affect the purchasing power of the territory concerned. Thus the export and import figures per head of the population of Nigeria, approximately one-fifth of those for the Gold Coast, do not give a true indication of the relative average incomes.

The author describes briefly the course and extent of economic development up to 1936, and then considers in greater detail the main elements, including crops, minerals, and communications, for the British territories, with a chapter on the French and Belgian possessions. He has not interpreted his theme narrowly, for the geographical environment is kept in view throughout, and land tenure systems and agricultural techniques receive attention. Though his book is largely historical and descriptive, he also indicates possible lines of improvement or development. A final chapter deals with finance and capital investment. Colonial finances are complicated by railway expenditure and fixed debt charges, but the proportion of revenue spent on economic development and social welfare combined affords a rough indication of the standard of life and of official policy, if allowance is made for the stage of development reached, natural resources, and other considerations. The proportion is highest for the Gold Coast, 44·3, and Uganda, 40·9 per cent.; but this figure represents for the Gold Coast an expenditure of 7*s* 4*d* per head only. The less advanced colonies can scarcely hope without assistance to raise their outlay to a figure which might be considered a reasonable minimum. Here the recently announced expansion of the Colonial Development Fund should redress the balance to some extent.

As to the share which the native populations can contribute to their own advancement, Sir Alan emphasizes the necessity for creating new income-producing activities "if the general standard of living and of health is to be raised above its present deplorably low level." In this direction too he sees the need for some control of the directions in which capital investment is applied.

This books performs a useful service by presenting in a small compass the facts upon which future colonial policy in Africa must be founded and thus enabling the reader to appreciate the issues at stake. G. R. C.

THOMAS BAINES OF KING'S LYNN; EXPLORER AND ARTIST, 1820–1875. By J. P. R. WALLIS. *London: Jonathan Cape*, 1941. 8×5½ *inches; 352 pages; maps and illustrations.* 12*s* 6*d*

It is strange that the African traveller and artist, Thomas Baines, should have had to wait until now for an adequate biography. He was a prolific writer and painter; much of his work was never published, and is now scattered in collections in England and South Africa. It required a student with the enthusiasm and patience of Professor Wallis to trace and collate all these sources. As a result he claims that there can be little left to learn of the subject of this biography.

Baines, the son of a master mariner, showed from an early age a talent for sketching: after an apprenticeship to a King's Lynn ornamental painter, his taste for adventure took him in 1842, at the age of twenty-two, to South Africa. Almost at once the lines upon which his career was to follow to the end were shaped: exploration supported by the sale of his pictures. He was also sufficiently enterprising to acquire a knowledge of field survey. To gain a living by painting in the South Africa of those days was a somewhat precarious undertaking, and many of the difficulties Baines encountered arose directly from lack of adequate support. There were four main episodes in his career: his early travels and adventures in South Africa, culminating in his service as an artist with the British forces in the Kaffir war of 1850–53; his experiences as artist-storekeeper with the North Australian expedition of A. C. Gregory; his work in a similar position with Livingstone's Zambezi expedition of 1858; and finally his work as leader of an exploratory party sent to Matabeleland to obtain a gold-mining concession from Lobenguela. Baines proved himself courageous, almost rash, hard working, and resourceful, an enthusiastic student of nature, preferring to observe rather than to shoot, and a man who appreciated the natives' point of view and strove to keep faith with them. Unfortunately for him his association with Livingstone proved unhappy, and he was finally charged with misappropriation of stores, and dismissed. Baines was never able to obtain a proper investigation into the charge, based in part on an alleged confession while delirious. The history of the expedition was marred with incidents of this nature. A party of men of differing outlook and experience, assembled and sent out incompletely equipped to the fever-ridden Zambezi—both Livingstone and Baines suffered seriously in health—offered many chances for personal quarrels. Livingstone as leader, without experience in controlling a party of this character, and bitterly disappointed when the Zambezi failed to prove the entry to Central Africa of which he had dreamed, appears to have listened too readily to the complaints of his brother Charles, who had early taken a dislike to Baines. The latter, who never ceased to maintain his innocence, was undoubtedly good natured and perhaps easy-going, but during his later career his honesty was never challenged, and his friends cordially supported him. These are the lines of Professor Wallis' case for Baines, and they undoubtedly carry great weight. Yet, owing to the conflicting evidence, it is not possible to decide the issue. It seems to be implied that Livingstone afterwards

admitted his mistake: this however is contradicted by the extract from a letter of his to the Rev. H. Waller, quoted by R. J. Campbell in his biography of Livingstone. It would perhaps not have been necessary to give so much space to this incident were it not that on at least two later occasions it prevented Baines being accepted for expeditions to Central Africa.

After leaving the Zambezi, Baines went to Cape Town and prepared for an overland journey to the Zambezi, hoping to reach Livingstone at Tete and to obtain a full inquiry. In company with the trader, James Chapman, he travelled from Walvis Bay through Ngamiland to the Victoria Falls, mapping the route carefully. Fever and lack of supplies compelled him to give up the prospect of a descent of the Zambezi. The days he spent examining and painting the falls were among the most memorable of his career.

During his last visit to England, where he was in demand as a lecturer, he accepted the leadership of an expedition to secure a mining concession from Lobenguela in Matabeleland, where Mauch had recently reported gold. Here again Baines was unfortunate: the exploring company gave him inadequate support, and after five years of hard travel, mapping, and negotiations, in the course of which he obtained a written concession, he was practically left stranded by them. It is to his credit that out of his own pocket he paid off many of the expenses incurred. Without his optimism and his tenacity, he might well have been daunted, but at the time of his death he was at Durban preparing a further journey.

It was Baines' practice to carry on all his journeys sketch-books, in which he would record the scenes and events which he afterwards worked up into paintings. He held no high theories of his art: his purpose was to record as accurately as possible what attracted and held his interest. A remark in his 'Explorations in South-West Africa' throws perhaps no unfair light on his outlook: he describes how he reluctantly assisted in destroying Chapman's photographic failures, "for in almost every one there is here and there some little bit of effective representation that I, as an artist, would give almost my right hand to reproduce." Nevertheless his sketches, four books of which are in the Society's collections, are often vigorous and lively, generally superior to the paintings later based upon them, and towards the end, as two sketches reproduced in this volume show, he displayed a much enhanced feeling for composition. Similarly, as a writer he admitted to prolixity, confessing that he found nothing too insignificant to note.

Professor Wallis tells his story straightforwardly, though at times the reader may be slightly confused with the smaller incidents of travel. He does not disguise where his sympathies lie, and summarises his subject in the words "If he missed his ends, he enjoyed himself by the way." There are a few misprints, of which perhaps the most unfortunate is "Whitechapel Place" for 15, Whitehall Place, a former house of the Society. G. R. C.

NORTH AMERICA

U.S.A.: AN OUTLINE OF THE COUNTRY, ITS PEOPLE, AND institutions. By D. W. BROGAN. 144 *pages.*

AMERICA'S ECONOMIC STRENGTH. By C. J. HITCH. 114 *pages.* (The world to-day.) *Oxford University Press,* 1941. 7½ × 4½ *inches; illustrations and sketch-maps.* 2*s* 6*d each*

These two books in the new series published by the Oxford University Press are most opportune. Mr. Brogan's essay is concerned with the political and social life of the United States in broad outline: though professedly dealing also with

the country, the geographical element is slight, beyond some emphasis upon the differences between the greater regions. The influence of this regionalism upon political life is also indicated in the wide range of social status and of the problems which engage the central authority. His chapter on government and politics gives a good summary of the present development of the constitution, and illuminates that puzzle to foreigners, the meaning of the epithets republican and democrat as applied to the great parties. He also writes interestingly of the functions of the Supreme Court. If his commentary is descriptive, and does not show the various bodies at work, he has added the text of the Constitution with the twenty-one amendments from which further enlightenment can be obtained. In other chapters he deals with influences which tend on the whole to cut across regional or state differences: religion, education, the press, literature, and so forth. He emphasizes the role of the educational system as a social and assimilative force, which has probably been of more importance than its purely instructional side. Mr. Brogan writes in a lively and independent manner, taking account of recent developments, in part from personal observation, and has skilfully avoided being entangled in a mass of detail.

Having finished Mr. Brogan's volume, which obviously can deal only with limited aspects of a vast subject, the reader may feel that there is still much to be learned of the life of the American people: he will find that this is supplied in part by Mr. Hitch's essay, though that is not its primary purpose. Mr. Hitch for example has something to say of national income and of the problems of the varying standard of living, particularly of the farming population, most pressing in the South and on the Western Plains. It is their relatively low standard that pulls down the national income average, despite the high wage-rates enjoyed by skilled labour. This essay also details the occupational movement away from the primary industries which has marked this century, and describes briefly the effects of the new deal legislation. The main purpose however is to examine the American industrial structure and the extent to which it can meet the needs of war. Machine methods, organization in large-scale units, the extensive use of power, and technical research ensure that the American workman can produce from a fraction more to four times as much as the British. But though peace-time economic strength means in the long run a strong war economy, the author has some pertinent remarks to make on the difficulties of a rapid transformation to a war basis. G. R. C.

CENTRAL AND SOUTH AMERICA

THE PRODIGIOUS CARIBBEAN. By ROSITA FORBES. *London: Cassell and Co.*, 1940. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 314 pages; illustrations and sketch-maps.* 15*s*

There has always been much uncertainty about the early life of Christopher Columbus. As with Homer many cities compete for the honour of being his birthplace, though Genoa appears to have the best claim, while Senor Salvador de Madariaga in his recent biography argues that he was a Jew, a belief shared by the present author. The first half of her volume is devoted to his early life and his four great voyages to the "Prodigious Caribbean," and the adjective perhaps best describes the style in which the book is written. Rosita Forbes draws the character of Columbus with its many aspects—a dreamer but a lover of gold; a navigator and sailor but hopeless as an administrator; his struggles with Ferdinand and Isabella for the recognition of his merits and for their due reward. All this is brought out in her flamboyant narrative. The second half of the volume deals briefly with the subsequent history of the islands; the Bahamas, Columbus' first landfall, the succession of pirates and raiders, and the migration

of empire loyalists from the American mainland colonies. In another chapter is sketched the history of Jamaica, also first discovered by Columbus and considered by the author to be the most beautiful and fertile of all the islands. Finally conquered by the English in 1670, it is associated with the memory of the valiant Benbow, Admiral of the White, a true pattern of English courage, who lost his life fighting his small ship against nine French men-of-war under Admiral de Pontes. Shortly after this Henry Morgan, the "wickedest man in history," pirate and arch traitor to his own people, was appointed Governor of Jamaica; so the tale runs on, an epic of chivalry, bloodshed, lust, and struggle for dominion.

Rosita Forbes has travelled widely throughout the islands, and she has given a vivid picture of the charms and delights of the "Prodigious Caribbean."

W. L. S.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

THIS STRANGE WORLD. By A. E. TRUEMAN. *London: John Gifford*, 1941. $8\frac{3}{4} \times 5\frac{1}{2}$ *inches;* 240 *pages; illustrations.* 8*s* 6*d*

'This strange world' surely demands a sub-title, for who would guess, who did not know the author, that the strangeness lay not in the character and behaviour of the world's living inhabitants, but in its geological history? Written originally for the Scientific Book Club, this work was designed, says Professor Trueman, not as an introduction to geology, but "as an outline showing what the subject is after, what it has achieved, and what are the problems with which it is concerned at the present time." Hence the reader is introduced to such topics as the Age of the Earth, the Inner Earth, the Origin of Continents and Oceans, Ice Ages, and indeed to all the more exciting and controversial aspects of earth-lore, especially those which the geologist shares with the geo-physicist and the geo-morphologist. Stratigraphy, fossils, petrology—those duller, but not less important matters which are the main preoccupation of the working geologist—are left aside as unlikely to attract the lay reader. The author complains that geological works have disappeared from the library shelves of the educated man, whereas a generation or so ago he read Lyell, or Geikie, as a matter of course. But that is surely because geological knowledge was then germane to controversies concerning man's origin and place in nature which shook the world but are now well-nigh forgotten. It is significant of the changed outlook of to-day that the reader who feels that geology is not his concern is asked to turn first to the final chapter of the book, where the main subject is the economic usefulness of geology in relation to soils, water supply, oil, minerals, and so on. Those who are familiar with Professor Trueman's pleasant little volume, 'Scenery of England and Wales,' will know that he has a gift, not only of lucid exposition, but of lucid illustration with his pencil. The diagrams, like the text, are little masterpieces of simplification. For that very reason however after telling the reader that he is left free to decide for himself between alternative hypotheses, concerning for instance the origin of continents and oceans, the author should surely warn him, in the interests of the scientific temper, that he is in no position to do anything of the sort.

E. G. R. T.

GENERAL

SONS OF SINDBAD. By ALAN VILLIERS. *London: Hodder and Stoughton*, 1940. 9×6 *inches;* xiv+346 *pages; illustrations and sketch-maps.* 20*s*

The author endured many privations and discomforts on his six months' voyage in an Arab dhow. He lived on the poop deck with the officers and so-called first-

class passengers, his only resting-place a bench on which was spread a carpet. The food consisted chiefly of half-rotten fish and rice partaken Arab fashion from a central dish. He had very little Arabic, at any rate at first, and had great difficulty in making himself understood. The ship was generally overcrowded, and no effort was made to clean it, so that the smell and the dirt were almost intolerable. Notwithstanding these drawbacks, Mr. Villiers enjoyed his experiences, and he has given what must be a unique picture of life on an Arab ship.

After completing his account of the cruise of the *Conrad* round the world, Mr. Villiers determined to learn at first hand all that was to be known about Arab seamanship in the Indian Ocean, and the social and commercial methods used from time immemorial. He went to Aden and then, through the help of Mr. Ingrams, the Resident Adviser in the Hadhramaut, and other friends, arranged for a passage in the big dhow or *boom*, *The Triumph of Righteousness*, to Zanzibar and back to Kuwait in the Persian Gulf. The cruise took over six months, and the present volume contains the narrative of the trip, full of observations on the habits and discrepancies of his shipmates, of their curious superstitions, their loyalties, and other fine qualities. One of the chief characters was Nedje, the *Nakhoda* or captain, a small but handsome hawk-nosed strong-faced man, who was, although entirely unversed in navigation, a capable seaman and very much in command of his ship. For a man of intelligence however he was exceedingly ignorant. When an eclipse of the moon occurred and Villiers tried to explain the reason for it, Nedje and his friends scouted any such explanation, and stated that it was well known that the moon was the Prophet's lamp in the heavens and the shadow was caused by an enormous jinn attacking the lamp.

The story of the voyage of *The Triumph of Righteousness* is full of such tales and is a fascinating account of the life of adventure and strange happenings as well as of the business and commercial undertakings of the trip. On the way down the coast the *boom* was laden with a mixed cargo of Basra dates, cottons and other piece goods, and perfumes. Much of this was the private speculation of the passengers and crew, and the bulk was smuggled ashore at the various ports they called at. On the return voyage the cargo consisted entirely of timber of mangrove trees from the Rufiji delta in Tanganyika, to obtain which a special trip was taken to that fever-stricken and mosquito-haunted spot. The timber was disposed of to Ibn Saud at a handsome profit.

After his return Mr. Villiers spent some months at Kuwait, during which he made an investigation of the pearling industry in which most of the inhabitants are interested. Owing to the competition of the Japanese culture-pearls and the depression in the European pearl market, Persian Gulf pearling is in a bad way. It is still carried on in the traditional manner without any diving apparatus, and the conditions in which divers live is disastrous to their health and lives. The author has written a most fascinating account of Arab ships and seamanship, and we can wholeheartedly commend it to readers in search of the novel and unknown. The excellent illustrations are all from photographs taken by the author. W. L. S.

THE MONTHLY RECORD

CASTELLÓRIZO

The small island of Castellórizo, recently occupied for a short time by the Allied forces, was visited by Dr. Hogarth some forty years ago. It is interesting to recall his impressions of this island as written in 'Accidents of an antiquary's life,' about 1910, for the conditions then must have been far different from those our troops would find after years of Italian rule. "Of all the Greek isles, Castellórizo lies most apart, outside the Archipelago, and nearly a hundred miles east of Rhodes, its motherland. . . . We climbed out on to the saddle of the twin-peaked rock, which is all the island. The southward slopes looked too naked for even a goat's subsistence. To northward the Lycian seaboard, rising to points and bars of snow, filled the distance. In the nearer view lay the burnished strait of Antiphellus, with a fishing fleet becalmed, and at our feet the white crescent of the town. Pointing to the mainland, we asked what concern the islanders had there? They pastured their few flocks, was the reply, cut wood, burned charcoal and owned orange and olive gardens or small farms. There were, indeed, several little colonies of Castellóriziote squatters, and one large village of their folk, Dembré, on the coast eastwards."

The islanders were mainly engaged in trade, and so it was around the harbour and port of Castellórizo that most of the people were concentrated: the harbour which recently was used as a sea-plane base by the Italians. "The town, more regularly laid out than most of its kind, rises in a horseshoe, tier on tier, from the port, whence radiate steep stone ladders dividing the wedges of habitation, as in the *cavea* of an ancient theatre. We strolled from one horn of the bay to the other; . . . heavily sparred brigs and two-masted caiques were packed that morning so close into the basin that a man might cross it dryshod; but the magazines and counting-houses round the port bore witness that these ships plied a gentler trade than that which once made a Castellóriziote sail a terror in the Levant. In fact, they traffic between the smaller Anatolian ports and Alexandria, where you may often see their antique high-pooped hulls lying under the breakwater, and what they carry is chiefly firewood and charcoal, cut and burned on the Lycian hills."

"The men, when they had shown us their pretentious marble church, garish with gilt carvings and Russian icons, led on to the schools, and first to that of the girls. It should have been a holiday; but I suspect the classes were warned as soon as we were seen to land, for no Greek can deny himself the pleasure of showing his scholars to a western stranger. As we came within the door the serried ranks arose, and the eyes of fifty maidens, each fit to bear Athena's *peplus*, looked into our own. Miserably we heard a hymn, miserably stammered incoherent thanks, and miserably fled. Who were we that we should patronise a choir of goddesses? "

MIGRATION TO AND FROM THE BRITISH ISLES

In a recent monograph with the above title, based on official returns, R. S. Walshaw discusses the movement of population since the last war, with special reference to the British Isles. During these twenty years, besides the great change from the volume of the pre-1914 movement, there have been changes in the type of movement. The author after considering the statistical evidence analyses the trends of movement, the emigration policy, emigration from Eire, and the migration of aliens into the British Isles. From 1922 to 1937 there was an inward balance of movement from Europe, although between 1922 and 1930

there was a loss of population from the United Kingdom to areas outside Europe and the Mediterranean. The net loss in 1923 was 190,000, followed by a gradual diminution until in 1932 there was a net gain of 49,000. This was succeeded by a slight net outward movement in 1938. This increase of population by immigration following the economic slump of 1931 was the first in the statistical records of this country.

After the last war emigration, which had previously been almost entirely voluntary, was resumed only with State aid and the cooperation of the Dominions and the United Kingdom under the Empire Settlement Act, 1922. During the period under review the United States was virtually closed as an immigration centre and later, owing to trade depression, the Dominions also found themselves unable to accept immigrants. In view of the declining birth-rate the author considers that further emigration from this country is likely to lead to a reduction of the standards of the home population.

Eire, where the birth-rate has always greatly exceeded the death-rate, has long had a great emigration and the majority of the people have gone to the United States, their traditional destination; hence Eire was particularly affected by the reduction in the Irish quota by the U.S.A. After this reduction more came to the United Kingdom where they showed preference for the Liverpool and Glasgow areas. Table 14, from which this excerpt is taken, is illuminating: the second and third lines apply to Eire only.

	Percentage of total emigrants going to		
	U.S.A.	*Dominions*	*United Kingdom*
1891–1900	89	4	6
1923	60	13	27
1931–37 ..	3	2	94

The author suggests that these immigrants from the Irish countryside should be sent direct to the Dominions, where they would be more suitable than the town dwellers of the United Kingdom, whom they are replacing.

There was a gradual increase from 1921 to 1938 of aliens who came to take up work in this country. About 45 per cent. of the permits to take up work were for domestic servants and 30 per cent. for stage and concert artists. Up to September 1939 aliens were only permitted to enter, apart from these special vocations, who were of independent means or refugees. In October 1939 there were over a quarter of a million aliens registered with the police, and of these 62,200 were German, 47,700 Russian and 19,100 Italians. A number of these aliens established new industries and so helped their new country.

This book is published, price 5*s*., by Jonathan Cape for the School of Social Sciences in the University of Liverpool. A. C. O

THE INDOBRAHM RIVER

The problem whether the Indobrahm or Siwalik River ever existed is discussed by M. S. Krishnan and N. K. N. Aiyengar in the *Records* of the Geological Survey of India, vol. 75, July 1940. On the southern side of the Himalaya, in the Indo-Gangetic plains, there is a thick series of Middle and Upper Tertiary deposits, known as the Murree Series (Lower to Middle Miocene) and the Siwalik (Upper Miocene to Lower Pleistocene). Two phases in the upheaval of the Himalaya are relevant in this connection: the first in Upper Eocene times when a fore-deep was formed, at least west of Dehra Dun: the second in the Middle Miocene, where all traces of the former Tethys are destroyed, and a marked furrow was produced all along the advancing mountains, and a southerly-directed drainage was initiated. In the Ganges-Brahmaputra area Siwalik rocks

were deposited in this furrow. In each division of the Siwaliks there is a predominance of sandstones in the lower portion, and abundant clays and shales above. There are also intercalations of conglomerates in the Upper Siwaliks, and, as a whole, the upper beds are coarser than the lower. The sandstones are usually cement-bedded—indicating fluviatile conditions. The whole series is over 16,000 feet thick, and they disappear under recent alluvium. Pilgrim and Pascoe argued that the Siwaliks were laid down by one great river flowing from Assam to the Punjab, and thence to the Arabian Sea. This river was later dismembered by what was really a process of capture. Annandale assumed that at one stage a more or less continuous marine strait occupied the Indo-Gangetic area: this became narrower with the uplift of the mountains, and streams draining from them filled it.

The present authors cannot accept the views of Pilgrim and Pascoe of a Siwalik (Indobrahm) river flowing from east to west, and they suggest that it is unreasonable to suppose that the great masses of Siwalik deposits were laid down by any such river, no matter how powerful it may have been. They argue that it is much more probable that these beds were deposited in a fore-deep. The view of R. D. Oldham that the similarity of the dolphins in the Indus and Ganges implies a former connection is also regarded as inadequate. Both species are more likely to have descended from a common marine ancestor in the Eocene Sea over north-western India. The Boulder conglomerate which forms a fairly constant horizon at the top of the Siwaliks is regarded as being due to the combined action of streams draining from the mountains directly on to the plains, helped in part by recent geological uplift and special flood conditions.

Messrs. Krishnan and Aiyengar certainly put forward a strong case against the assumed east–west river: it is a pity that their interesting and welcome paper is not illustrated with an adequate map. J. A. S.

DESICCATION IN SOUTHERN ONTARIO

In an article with the above title (*Trans. R. Soc. Canada*, 34, 1940), A. F. Coventry describes a survey of the drainage areas, totalling about 1300 square miles, of various streams which flow into Lake Ontario between Dundas at the western end of the lake and Toronto. The investigation was undertaken because the waters of southern Ontario are now diminished much below their volume of even a few decades ago, many streams flowing only intermittently, wells periodically failing, and ponds once permanent drying during summer. In 1939 the Ontario Forestry Board drew attention to the prevalence of desiccation associated with erosion over large areas of the province, and instigated a survey of the King Township district in York County, Ontario, where conditions were reported to be very bad, though, as Mr. Coventry shows, not exceptionally so.

The outstanding indications of Mr. Coventry's hydrological survey are given on a map which distinguishes the permanent streams from those which dry up during the summer, and the general impression conveyed is confirmed and emphasized in a table of percentage distribution of the two classes of streams. It appears that of the rivers which originate in the upland area more remote from the lake 62 per cent. are permanent, but only 18 per cent. of the shorter streams originating in the lowland tract between the uplands and the lake are permanent. In other words, to each square mile of upland there is 0·63 mile of permanent stream, but in the lowlands the corresponding figure is no more than 0·23 mile of stream. A further table relating the distribution of the permanent streams to the character of the land brings out the significance of the above figures; the uplands retain 23 per cent. of uncleared land, the lowlands

only 10·5 per cent. It is pointed out however that even the more favoured uplands cannot keep in action all the streams with which they were originally endowed, for there are streams running over the escarpment in spring as considerable falls which by summer are dry, and some of these have in the past supported mills. There seems to be a clear case for attributing the growing water shortage to erosion consequent upon uncontrolled exploitation of the forests, and remedial action based on extensive investigations is called for.

THE NITRATE DEPOSITS OF TARAPACÁ, CHILE

In the *Journal* for January 1940 attention was drawn to a fine set of air photographs of the Appalachians by Dr. J. L. Rich: he has followed these up in the *Geographical Review* for January with a series illustrating the location of the nitrate deposits of Tarapacá, Chile, made during a passenger flight from Tocopilla to Arica. Though perhaps not as striking as the earlier set, they show the relation of the nitrate workings to the Coastal Range and to the playas and salars of the longitudinal valley to a degree which could not be fully appreciated from the ground.

The deposits are the result of a combination of aridity, old relief, and a source of nitrogen which has yet to be fully explained. The salts occur in a crust, called *caliche*, near the desert surface, having been precipitated by ground water rising to the surface. Above the caliche is the *costra*, a strongly cemented mixture of chlorides and sulphates, which is in turn covered by the loose surface soil. The deposits lie in general along the slopes of the Coastal Mountains on the western side of the longitudinal valley, above and close to the border where the old surface of the mountains dips eastwards beneath the recent valley fill. No fault line is visible here, though numerous small transverse faults are present: if the valley is due to faulting, the fault line is hidden by the sediments. The caliche is from 3 to 6 feet below the surface, and ranges from a few inches to several feet in depth. The excavations are therefore plainly visible from the air, and the photographs may contribute to solving the problem surrounding the formation of these deposits. Dr. Rich discusses several theories, and concludes that two are more probable. Whitehead has suggested that the nitrates are derived through the weathering of the Mesozoic tuffs and lavas that form the bedrock over most of the area, and that they have been concentrated on the lower slopes by ground water. Brüggen finds a possible source of nitrogen in former guano deposits along the coast, from which nitrogenous gases were blown inland. Certain details however tell against both these hypotheses. All the conditions of occurrence mentioned above can be seen in the illustrations, as well as the character of the Coastal Range and the construction of the officinas, with their conspicuous waste heaps. A sketch map records the position and direction of each exposure.

THE INDUSTRIAL DISTRICT OF NEWCASTLE, N.S.W.

The importance of the Newcastle district, New South Wales, in the economic structure of Australia is outlined by Dr. C. M. Zierer in *Economic Geography* for January 1941. The fertile land of the Hunter River valley attracted settlers from an early date, and from the beginning small quantities of coal were dug from the headland at the mouth of the river. The first important stage in its development was the granting of 500 acres of coal lands to the Australian Agricultural Company in 1826; by 1865 the annual output had grown to 300,000 tons. The coal measures of the New South Wales basin outcrop in the Newcastle area at 200 feet, and are easily workable, and the proximity of the

estuary of the Hunter River permits export by sea, thus neutralizing the early isolation of the area. The harbour at Newcastle is protected by breakwaters from south-easterly winds, and a channel 25½ feet deep at low water is maintained. At the end of the last century the lower coal measures of Maitland, about 25 miles inland, were developed, and this area is now the centre of the Australian coal industry. The Maitland coal is particularly suited for the manufacture of gas, and is a good steam coal for railways and ships; the Newcastle coal however is better for coking. The Maitland field has a private railway connection with tide water at Hexham, 10 miles above Newcastle, and is also linked with the export docks at Newcastle. This area produces about half the Commonwealth coal output. At the peak of the export trade in coal, about one-third of the coal sent out of the Newcastle area went overseas. In 1913 this amounted to 3·5 million tons, but the closing of markets and competition from other producers had reduced this to 0·66 million tons by 1930. The home market has also declined, though not to the same extent, as the other States have developed alternative sources of power, for example, water power in Tasmania and the lignite deposits of Victoria.

With the diminution of the export market however a local market was established by degrees. Coke manufacture had been begun as long ago as 1861, but the output became important with the setting up of the Broken Hill Proprietary Company's plant in 1915. The Company's steel works and bye-products plants soon became an important consumer of the coal which was no longer finding a foreign market. The seaboard position of the field gave cheap access to the iron ore of South Australia and to the Tasmanian limestone. After the establishment of blast furnaces and rolling mills, the Company undertook the making of railway material, and sheet, wire, and pipe products. Zinc ores are treated at Cockle Creek, and the by-product sulphuric acid is used with rock phosphate from Nauru and Ocean Islands for the manufacture of artificial fertilizers, for which the Australian demand is large. A number of minor industries have also developed, and steps have been taken to make Newcastle an export centre for the agricultural produce of northern New South Wales. In 1936 an elevator capable of handling 800,000 bushels of wheat in bulk was opened. The importance of Newcastle as a wool market is also increasing. The stages in the industrial development are reflected in the growth of population: from 1881 to 1911 the population of Newcastle was practically stationary at fifty thousand, but with the introduction of the steel and other manufactures it had steadily risen to one hundred and five thousand by 1933.

GLACIER RECESSIONS AND TEMPERATURE RECORDS

In the *Monthly Weather Review* for June 1940 Mr. J. B. Kincer refers to a report of the Committee of Glaciers as published in the *Transactions of the American Geophysical Union* for 1939, and relates the findings to modern temperature trends. The report confirms the general impression among geographers that in recent times glaciers have been receding all over the world. Historical evidence is given by Charles Rabot indicating that the glaciers of the French Alps began to advance about the end of the sixteenth century and continued to do so till the middle of the nineteenth century, since when they have been steadily retreating. In Iceland Thorarinsson by searching old records has succeeded in tracing the history of glacier oscillation in that island back to 875, when the Norsemen established their first colonies, and he finds that there too recession of the glaciers began about the middle of the nineteenth century. Similarly observations by Munday on the great Klinaklini and Franklin glaciers in British Columbia and on the Nisqually glacier of Mount Rainier, Washing-

ton, show at the present time recession from a maximum advance which must have occurred shortly after the middle of last century.

Mr. Kincer states that our longest weather records, extending back in some cases to the latter part of the eighteenth century, show conclusively that since about the middle of last century, a point which corresponds with the beginning of the current glacier recession mentioned in the report, there has been a marked rise in temperature especially in America. The upward trend is illustrated in a number of graphs largely for places in the United States but including some in Europe and South Africa. One graph shows for one hundred and twenty-two years, 1819–1940, the departure from the average of the mean temperature of the cold half-year, October–March, at Washington, D.C. The average for the entire period is 41·8° F., the same as for the forty-seven-year period 1875–1921, adopted as the standard normal. As a normal computed from the last forty-seven years would be too high, and for a like period in the earlier part of the record too low, the normal period chosen is considered to be representative. Another Washington graph for the decade 1929–38 gives the departure from the 1875–1921 standard, of mean temperature month by month, season by season and year by year. In these ten years, 75 per cent. of the one hundred and twenty months had temperature above normal, and 90 per cent. of the forty seasonal quarters, and there was only one year below normal. Similar tendencies are disclosed for stations scattered all over the globe according to summaries published in the *Reseau Mondial*.

MEETINGS: SESSION 1940–41

Twelfth Meeting, 3 February 1941. The President in the Chair

Elections: K. R. Hauch; E. J. Hughes, B.A.; Captain Cuthbert Tyrwitt

Paper: Alpine New Zealand. By Mr. Alan Browne

Thirteenth Meeting, 10 February 1941. Admiral Sir William Goodenough, Vice-President, in the Chair

Paper: Port facilities and the dispersal of industry: the problem in Scotland. By Mr. Andrew C. O'Dell

Fourteenth Meeting, 17 February 1941. The President in the Chair

Elections: Mrs. M. H. Austin; J. M. Cleary, B.A.; H. A. Matier; Lieut. E. S. Roberts, A.R.I.B.A., R.E.; R. Shephard

Paper: The Islands of the Aegean. By Professor J. L. Myres

Fifteenth Meeting, 24 February 1941. Geographical colour films: The 1938 P.S.E.S. Expedition to Newfoundland, shown by Major D. L. Paterson

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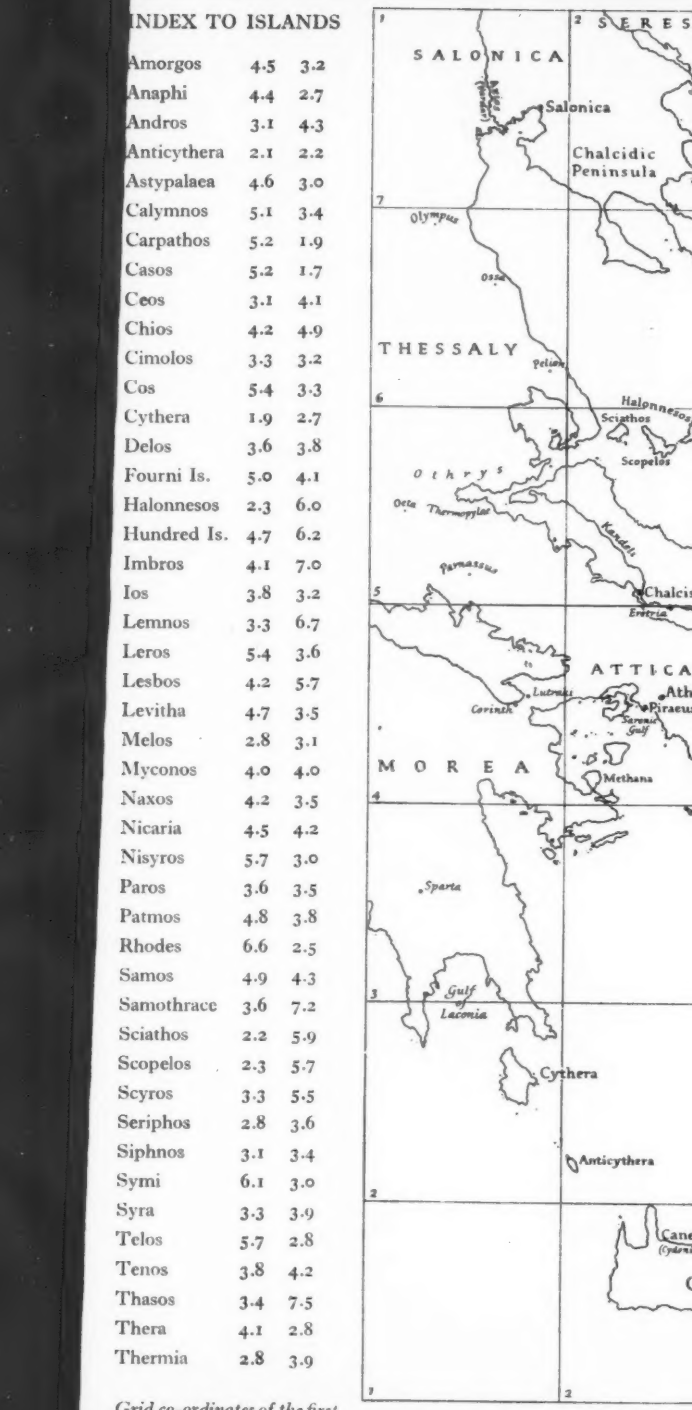
Amorgos	4.5	3.2
Anaphi	4.4	2.7
Andros	3.1	4.3
Anticythera	2.1	2.2
Astypalaea	4.6	3.0
Calymnos	5.1	3.4
Carpathos	5.2	1.9
Casos	5.2	1.7
Ceos	3.1	4.1
Chios	4.2	4.9
Cimolos	3.3	3.2
Cos	5.4	3.3
Cythera	1.9	2.7
Delos	3.6	3.8
Fourni Is.	5.0	4.1
Halonnesos	2.3	6.0
Hundred Is.	4.7	6.2
Imbros	4.1	7.0
Ios	3.8	3.2
Lemnos	3.3	6.7
Leros	5.4	3.6
Lesbos	4.2	5.7
Levitha	4.7	3.5
Melos	2.8	3.1
Myconos	4.0	4.0
Naxos	4.2	3.5
Nicaria	4.5	4.2
Nisyros	5.7	3.0
Paros	3.6	3.5
Patmos	4.8	3.8
Rhodes	6.6	2.5
Samos	4.9	4.3
Samothrace	3.6	7.2
Sciathos	2.2	5.9
Scopelos	2.3	5.7
Scyros	3.3	5.5
Seriphos	2.8	3.6
Siphnos	3.1	3.4
Symi	6.1	3.0
Syra	3.3	3.9
Telos	5.7	2.8
Tenos	3.8	4.2
Thasos	3.4	7.5
Thera	4.1	2.8
Thermia	2.8	3.9

Grid co-ordinates of the first letter of the name.



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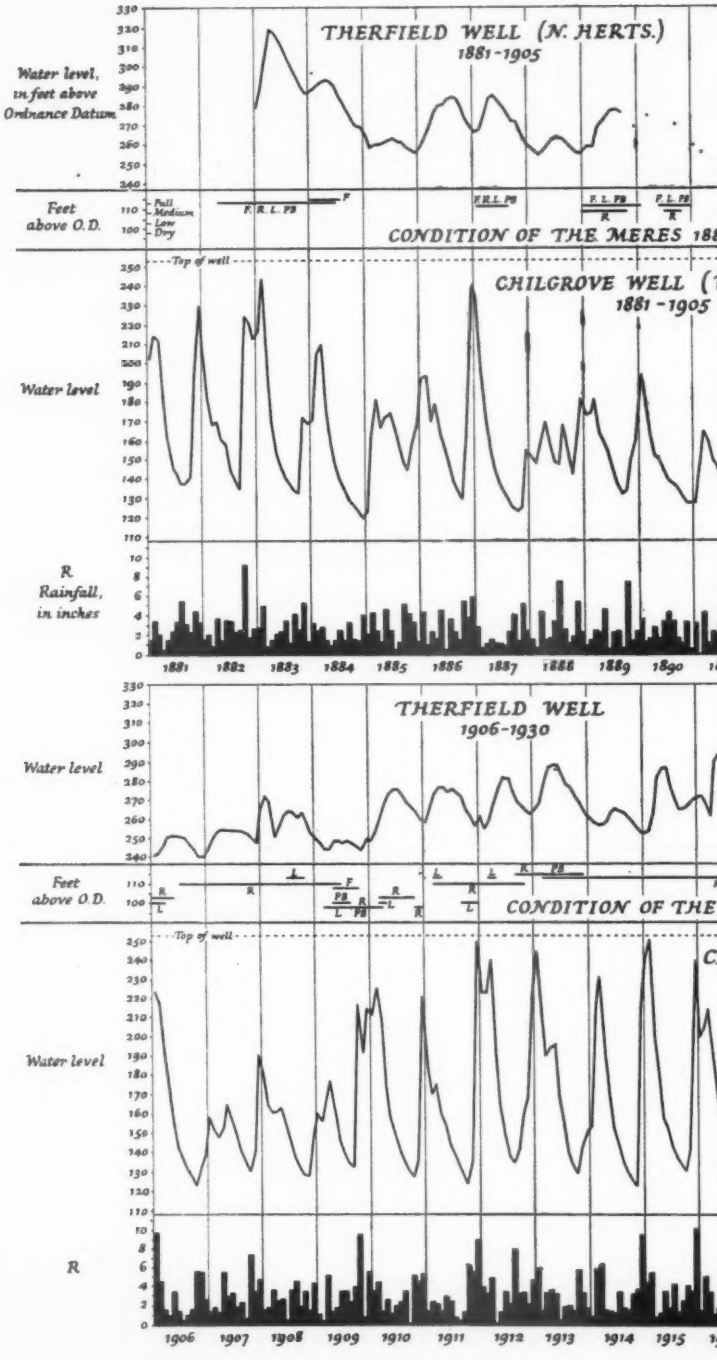
ISLANDS OF THE AEGEAN
Myres

PLATE 1



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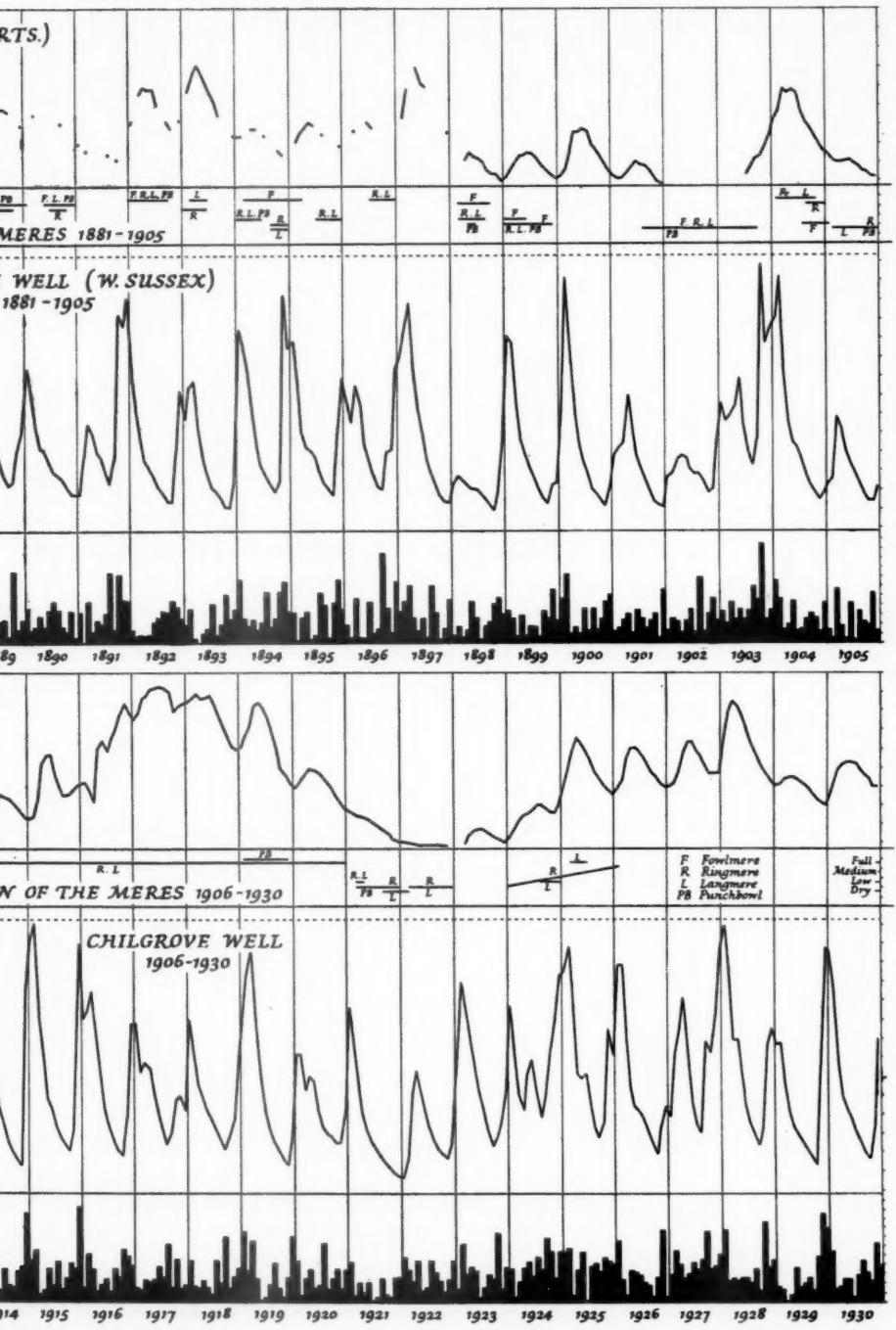
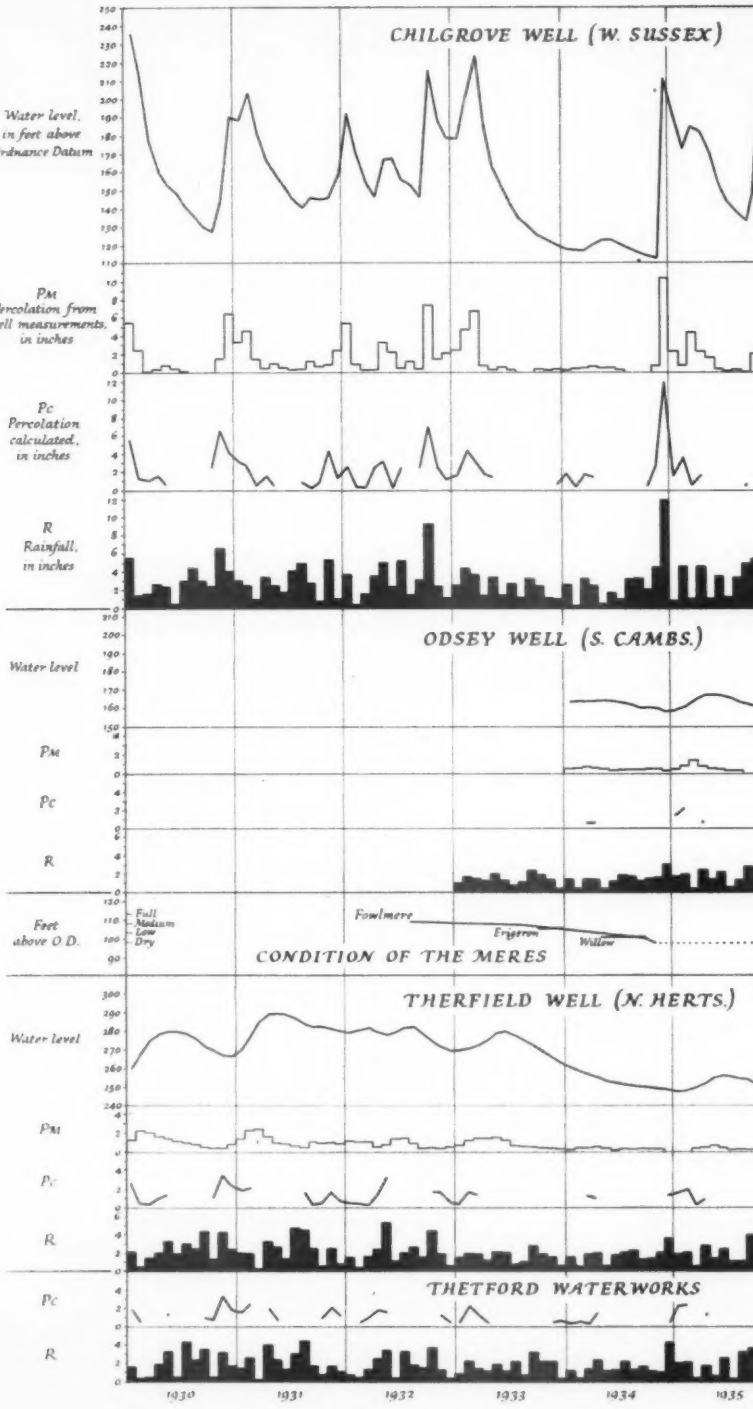


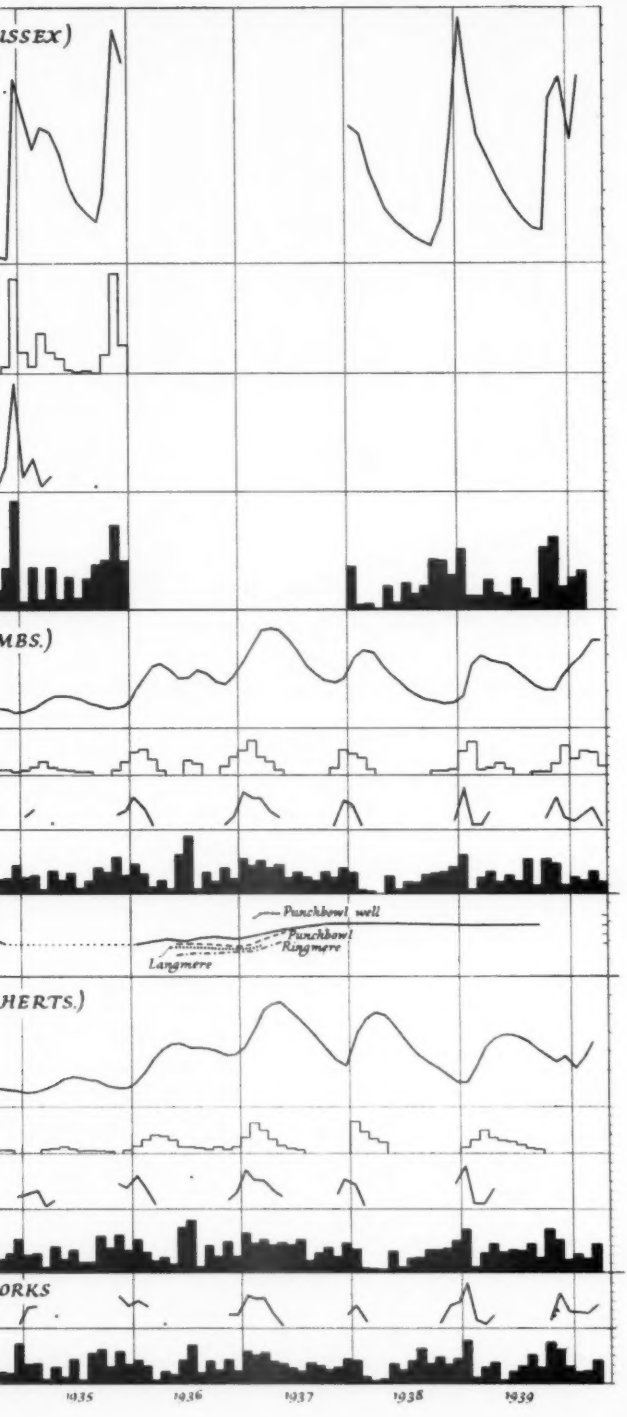
THETFORD MERES
Jones and Lewis

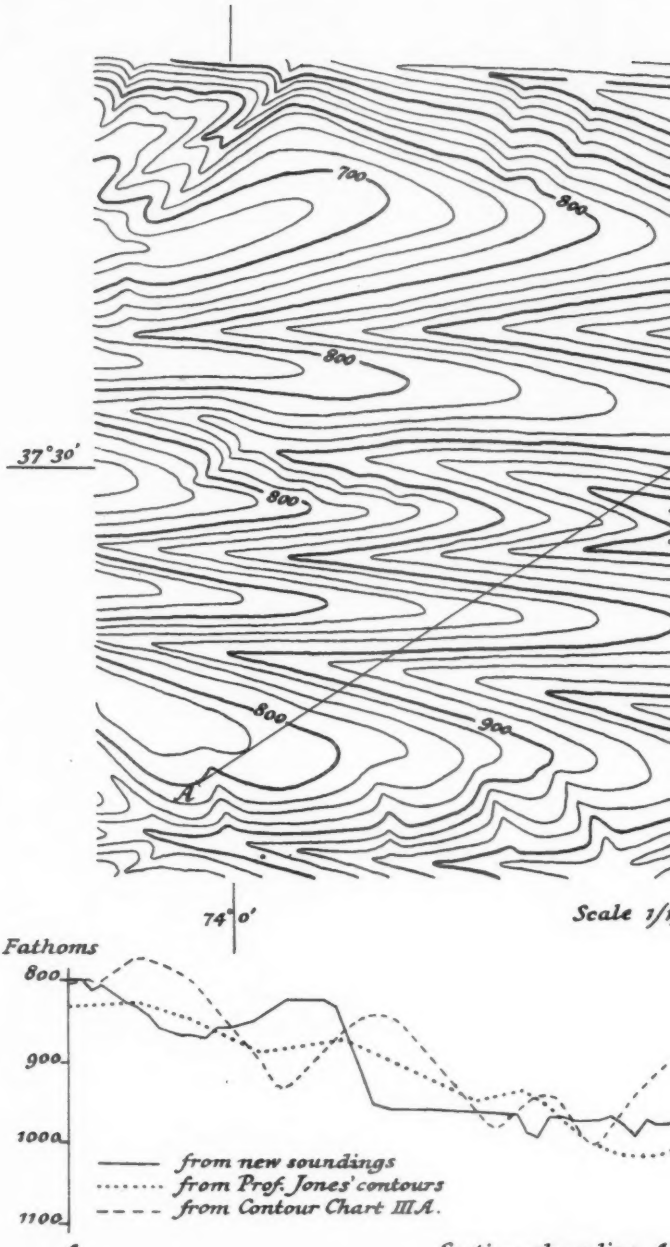
PLATE 2

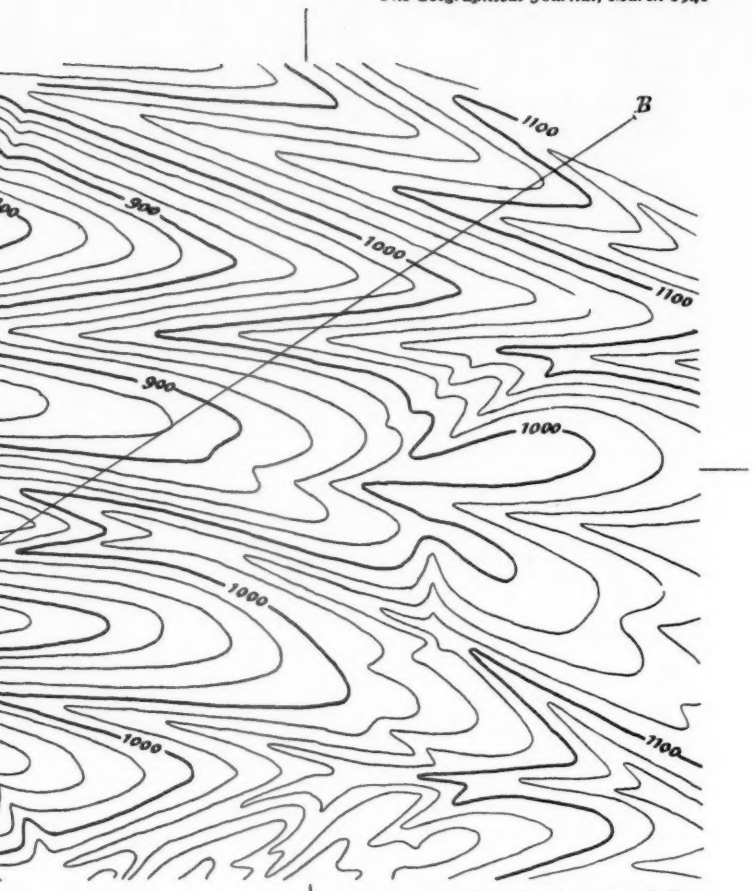


THETFORD MERES

Jones and Lewis


ASSEX)
MBS.)
Punchbowl well
Punchbowl
Ringmere
Langmere
HERTS.)
ORKS
1935
1936
1937
1938
1939

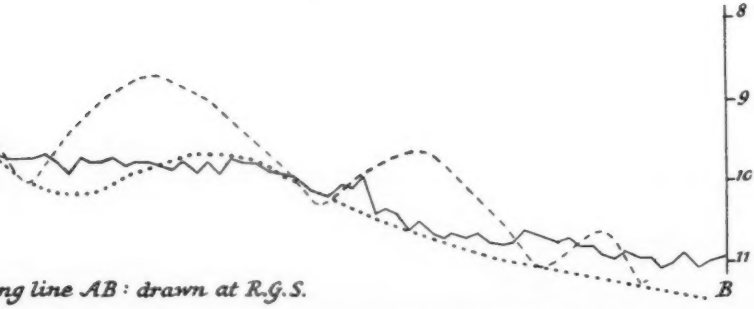

700
800
800
37°30'
800
800
900
A
74°0'
Scale 1/
Fathoms
800
900
1000
1100
from new soundings
from Prof. Jones' contours
from Contour Chart III A.
A
Section along line A



Scale 1/150 000

73° 50'

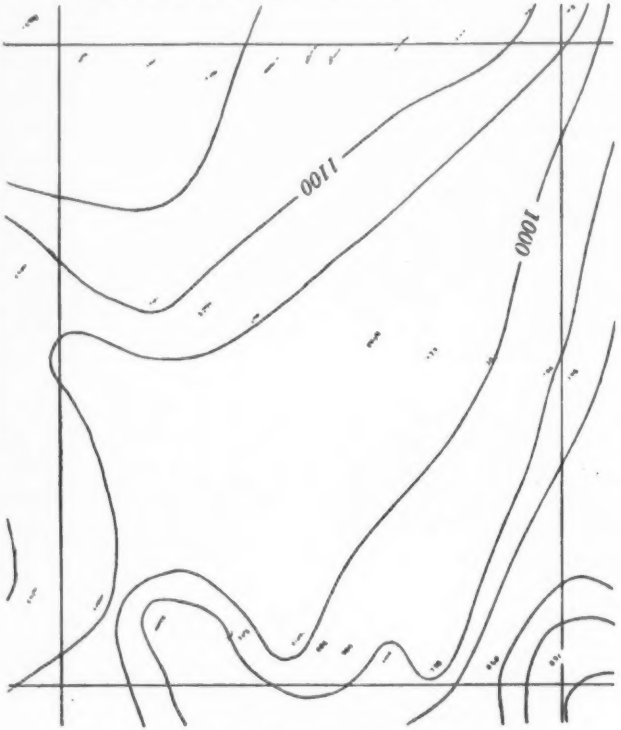
Reduced from Chart IIIA, S.P. No. 7
Geol. Soc. America



ng line AB : drawn at R.G.S.

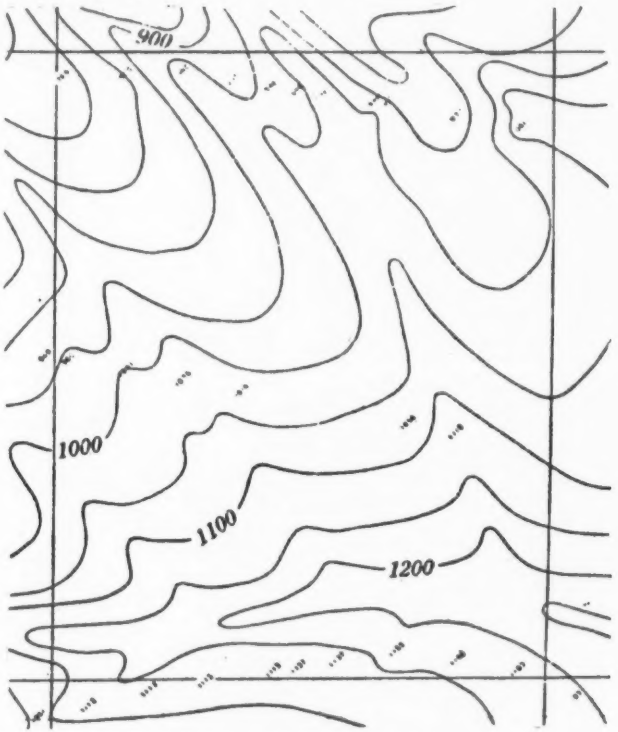
CONTINENTAL SLOPES AND SHELVES
Jones

From Fig. 24, S.P. No. 7 Geol. Soc. Amer.



Mechanical Connections 1933

From Fig. 25

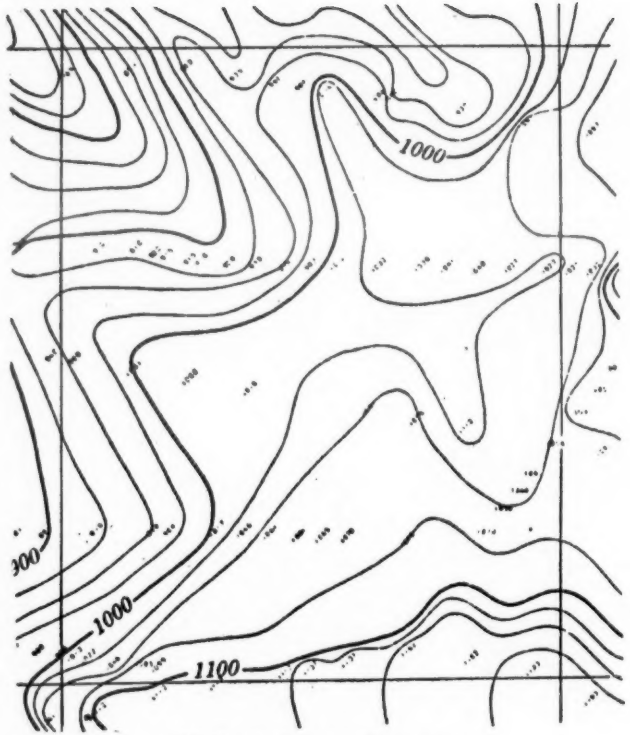


Topographic Contours 1933

From Fig. 26

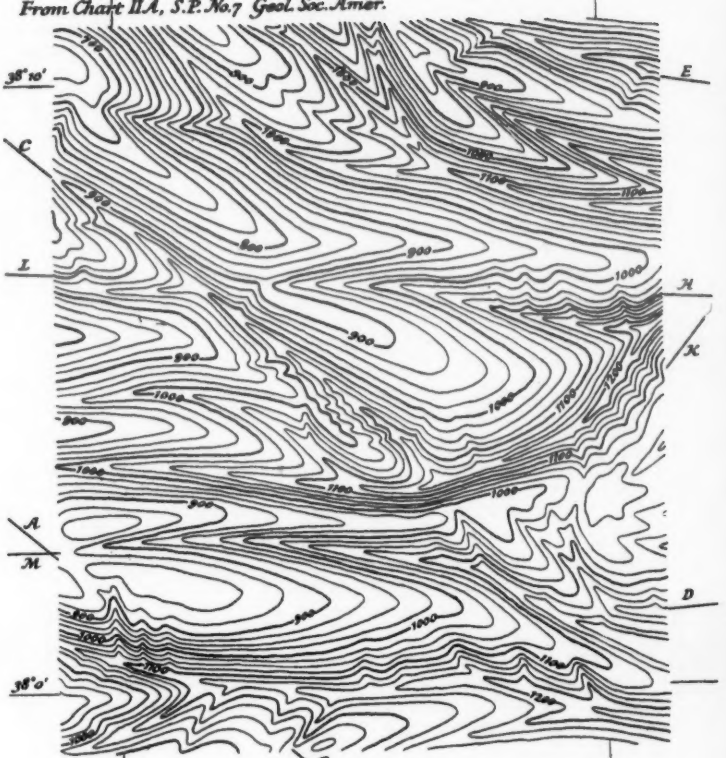
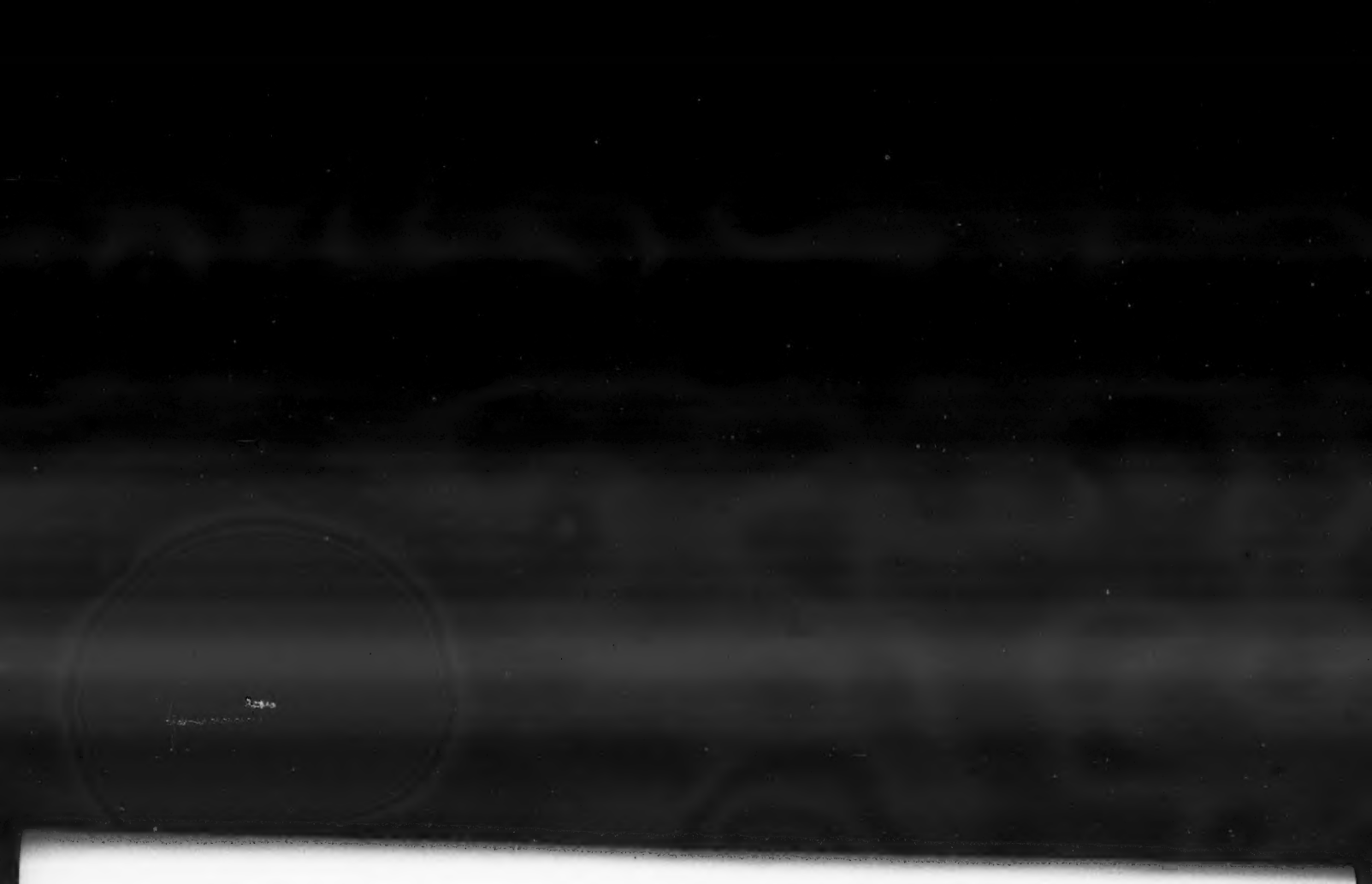
From Chart IIA, S.P. No. 7 Geol. Soc. Amer.

From Fig. 26



Mechanical Connections 1934

From Chart IIA, S.P. No.7 Geol. Soc. Amer.



Topographic Contours 1938